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SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Live Material for Parasite Study

Ratio or Concrete Quantities

Osmosis Experiment

Aquarium Plants

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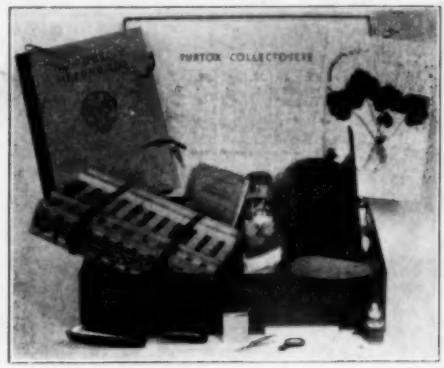

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PLANE GEOMETRY

Elizabeth B. Cowley, Ph. D.

Twenty years spent as a teacher of mathematics in Vassar College gave to Dr. Cowley the incentive and the opportunity to study the results attained in mathematics in many types of secondary school. This study led her to resign her college position and to engage in teaching in a public high school in Pittsburgh. Her experience in college and in high school convinced Dr. Cowley that there is need for a textbook in plane geometry which students in secondary schools can really comprehend and which will furnish increased opportunity for the mastery of the concepts and ideas of plane geometry. The results of the author's experience and study are embodied in this book. Its materials and its methods have been subject to continuous trial in the classroom over a period of years. The results, judged by scores made in geometry tests and by the ability of her students to maintain themselves in mathematics in leading colleges, mark PLANE GEOMETRY as a long-lived text.

THE STORY BEHIND THE BOOK

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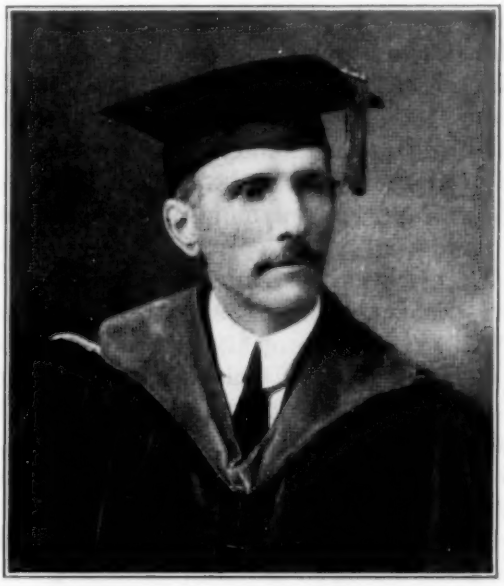


FLORIAN CAJORI—A TRIBUTE *

BY EDWIN W. SCHREIBER,

State Teachers College, Macomb, Ill.

When the sun goes below the horizon, he is not set; the heavens glow for a full hour after his departure.—And when a great and good man sets, the sky of this world is luminous long after he is out of sight—Such a man cannot die out of this world.—When he goes he leaves behind much of himself.—Being dead he speaks—Henry Ward Beecher.

The last news I received from the living Florian Cajori

*Read before the Mathematics Section of the Central Association of Science and Mathematics Teachers, Chicago, November, 1931.

was in July, 1930. It was my good fortune to be on the summer staff of the University of Wisconsin and when Prof. E. R. Hedrick of the University of California at Los Angeles paid us a visit I inquired of him concerning the welfare of his colleague and my friend, Prof. Cajori. "He has failed some in the last few years but he is still working, in fact he is very much interested in getting out a new edition of Newton's Principia." For several days thereafter I found myself frequently musing about this great scholar and how he had been nurtured at Wisconsin some fifty years before. A month rolled around and I was back at my post in Illinois when one evening I was stunned in reading the following brief note in Science (August 29, 1930): "Dr. Florian Cajori, professor emeritus of the history of mathematics at the University of California, died at Berkeley on August 14. Professor Cajori was born in Switzerland in 1859 and received the bachelor's degree from the University of Wisconsin in 1883." Thus a great and good man had passed on, barely rounding out his allotted three score years and ten.

Florian Cajori was born at St. Aignan, near Thusis, Switzerland, February 28, 1859. He came to the United States in 1875, at the age of sixteen. In 1883 he received the B. S. degree from the University of Wisconsin. The year 1884-85 he spent in graduate work at Johns Hopkins. He then went to Tulane University as assistant professor of mathematics, becoming professor of applied mathematics two years later (1887). In 1889 he went to Colorado College as professor of physics, subsequently taking the chair of mathematics (1898-1918) and becoming dean of the department of engineering (1903-1918). During all these years he paid particular attention to the history of the subject of his major interest, and in recognition of his work in this field he was called in 1918 to the University of California as professor of the history of mathematics. He himself told me in a personal conversation at the A. A. A. S. meeting in Cincinnati, 1923, that so far as he was able to determine he was the only man in the university world holding the title: professor of the history of mathematics.

His first publication appeared in 1890 when he prepared for the United States Bureau of Education a monograph on the "Teaching and History of Mathematics in the United

States." This was followed by a "History of Mathematics," 1894; "A History of Elementary Mathematics," 1896; and a "History of Physics," 1899. All of these books were received with enthusiasm and are still widely used, having been thoroughly revised since he came to California.

He was then invited to contribute to the fourth volume of Cantor's "Vorlesungen uber Geschichte der Mathematik" (Leipzig, 1908). From this time on to the day of his death his scholarship became more and more profound and the number and quality of his contributions to the history of mathematics increased steadily. He published a "History of the Logarithmic Slide Rule" in 1909, and "William Oughtred," a study of the great English mathematician, in 1916.

At the University of California he was relieved of administrative work, and of routine teaching of elementary mathematics, so that he was able to devote himself largely to research, the results of which were embodied in not less than 140 contributions to various journals in this country and abroad, together with the following books: "History of the Concepts of Limits and Fluxions in Great Britain from Newton to Woodhouse," in 1919; "The Early Mathematical Sciences in North and South America," 1928; "The Chequered Career of Ferdinand Rudolph Hassler, First superintendent of the United States Coast Survey," 1929; and "History of Mathematical Notations" (2 volumes), 1928-1929, a truly monumental work of encyclopedic character. He had also completed editions of Newton's "Principia" and Newton's "Optics," which are in process of publication. He had come to be recognized as the leading historian of mathematics in this country, and became professor emeritus in 1929 at the height of his activity.

He was a member of many scientific societies, was president of the Mathematical Association of America in 1917, vice-president of the History of Science Society in 1924 and 1925, vice-president, section L, American Association for the Advancement of Science in 1923, vice-president of the Comité Internationale d'Historie des Sciences in 1929, honorary member of the Central Association of Science and Mathematics Teachers, 1913—. He was granted the honorary degrees of Ph. D., Tulane 1894, Sc. D., Wisconsin 1913, LL.D., Colorado College 1913, LL.D., California 1930.

Professor Cajori appeared twice on the general programs of our own association, at St. Louis in 1907, and again at Des Moines in 1913. On both of these occasions he also appeared on the program of the Mathematics Section. His deep and abiding interest in the Central Association and its official journal, SCHOOL SCIENCE AND MATHEMATICS is evinced by the following list of his papers published in our Journal:

Lessons drawn from the history of science, Vol. VIII, Feb. 1908, pp. 85-96.

Discussion of the report of the committee on algebra, Vol. VIII, Mar. 1908, pp. 205-208.

Graphic railroad time-tables, Vol. X, Mar. 1910, pp. 204-205.

Attempts made during the 18th and 19th centuries to reform the teaching of geometry, Vol. XI, Apr. 1911, pp. 330-355.

Science and Mathematics in vocational schools: a retrospect, Vol. XIV, Feb. 1914, pp. 97-108.

A new marking system and means of measuring mathematical abilities, Vol. XIV, Apr. 1914, pp. 283-294.

Anomalous forms in writing numbers, Vol. XVI, Mar. 1916, pp. 246-248.

On the history of "Playfairs' parallel postulate," Vol. XVIII, Dec. 1918, pp. 778-779.

How X came to stand for unknown quantity, Vol. XIX, Nov. 1919, pp. 698-699.

Talk on logarithms and the slide-rules, Vol. XX, June 1920, pp. 527-531.

Minimum high school mathematics, Vol. XXI, Jan. 1921, pp. 25-29.

Falling bodies in ancient and modern times, Vol. XXI, Oct. 1921, pp. 638-649.

Tangent lines among the Greeks, Vol. XXII, May 1922, pp. 463-465.

Origin of the names arithmetical and geometrical progression and proportion, Vol. XXII, Nov. 1922, pp. 734-737.

Tangent lines again, Vol. XXIII, Jan. 1923, pp. 64-66.

The evolution of our exponential notation, Vol. XXIII, June 1923, pp. 573-581.

Isaac Newton's experiments on light, Vol. XXVIII, June 1928, pp. 618-627.

As additional evidence that Professor Cajori was truly interested in the history and problems of mathematical pedagogy on the high school level the following list of his papers is appended. These contributions are to be found in the *Mathematics Teacher*, the official journal of the National Council of Teachers of Mathematics.

Robert Recorde, Vol. XV, May 1922, pp. 294-302.

Recent symbolisms for decimal fractions, Vol. XVI, Mar. 1923, pp. 183-187.

Unification of mathematical notations in the light of history, Vol. XVII, Feb. 1924, pp. 87-93.

Fanciful hypotheses on the origin of the numeral forms, Vol. XVIII, Mar. 1925, pp. 129-133.

Controversies on mathematics between Wallis, Hobbes, and Barrow, Vol. XXII, Mar. 1929, pp. 146-151.

Absurdities due to division by zero, Vol. XXII, Oct. 1929, pp. 366-368.

The underlying philosophy of his historical contributions is well characterized in his introduction to "A History of Mathematical Notations": "If the object of this history of notations were simply to present an array of facts, more or less interesting to some students of mathematics—if, in other words, this undertaking had no ulterior motive—then indeed the wisdom of preparing and publishing so large a book might be questioned. But the author believes that this history constitutes a mirror of past and present conditions in mathematics which can be made to bear on the notational problems now confronting mathematics. The successes and failures of the past will contribute to a more speedy solution of the notational problems of the present time."

In closing I should like to quote from the last paragraph of the resolution prepared by a committee of the faculty of the University of California, Prof. M. W. Haskell, Chairman, which was ordered spread upon the minutes of the Academic Senate and a copy sent to Professor Cajori's family:

"He was also a first-class teacher and administrator, intensely loyal to his colleagues and devoted to his students, who loved him as an elder brother and confided their problems and troubles to him, sure of sympathetic and wise

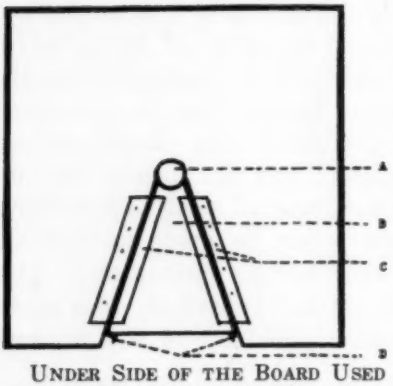
counsel. All of us who were privileged to know him were impressed with his straightforward honesty, his discriminating judgment and his warm-hearted friendship. He quickly established in our hearts a respect and regard which will keep his memory green. His death on August 14, 1930, was a profound loss to this University, to whose reputation he contributed greatly, as well as to his colleagues and students who have lost a dear friend."

A DEVICE FOR DEMONSTRATING TRANSPIRATION

By D. C. Barrus, *Mount Hermon School, Mount Hermon, Mass.*

The usual method of performing the experiment in transpiration by covering a flower pot containing a plant like the geranium with rubber and permitting the stem and leaves to protrude through the covering and placing a bell jar over it all has a few difficulties. Its use is often restricted to small plants and also the evaporation of the water from the soil in the pot is not always easily prevented.

The simple device which is described below has been found very easy to use and effective in results. An added advantage is that the apparatus can be kept in very good shape from year to year. It can very easily be made.



Under Side of the Board Used in Transpiration—A—Hole for the Stem, B—Removable Triangular Piece of Wood, C—Cleats to Support B, D—Pegs.

A smooth piece of one inch pine about ten inches square serves very well. A three-eighths inch hole is bored in the center of the piece. A triangular section with a four inch base is then cut out of one side in such a way as to have the space formed by this triangle continuous with the hole in the center. When the apparatus is in use the triangular piece is held in place by two metallic zinc cleats which support it and two pegs which hold it firmly in place. The accompanying diagram shows the arrangement of these parts. The entire piece should be well painted for the water from transpiration will cause wood not properly protected to warp.

When setting up the experiment remove the triangular piece and place it on the plant in such a manner as to have the stem fit through the hole. Replace the piece and firmly fasten it in with the pegs. Pack cotton in the hole around the stem. By means of tripods or iron supports and clamps arrange the apparatus in a horizontal position. Cover the upper side of the piece with melted paraffin and while it is still soft fit a suitable bell jar over the stem and leaves and the paraffin will seal it in place. After a few hours moisture will be seen to form on the inside of the jar.

EXTENSION WORK IN EARTH HISTORY

By DON L. CARROLL,
Associate Geologist, Illinois State Geological Survey, Urbana, Ill.

In the State of Illinois there are more than 900 high schools—almost a thousand. Yet, in all but a scant two dozen of them, no real attempt is being made to teach the essentials of earth history to the students who attend them. This means that most of the boys and girls of today are acquiring mistaken ideas, or have no ideas at all, about the nature of the world in which they live—of its origin, of the geologic processes which have made it what it is today, and which are still in constant operation; in fact, they are not even familiar with geological conditions in their own localities in various parts of the State. And unless they go on to college, there is little chance that they will ever assimilate this most broadening of all information.

Like most areas of similar size, Illinois has had a surprisingly interesting history, which we can read from the various rock formations and glacial deposits which are present within its boundaries. The facts about this earth history as applied to our own State should be common knowledge. People should know, for instance, that the sea, spreading northward from the present Gulf of Mexico, covered this part of the continent at least forty different times during the millions and millions of years before the appearance of man upon the earth. There can be no argument about the existence of these ancient seas—the records of their invasions are clearly preserved in the limestone, sandstone and shale rock formations that have been carefully studied throughout the State.

The people of Illinois should be thoroughly familiar with the story of the immense sheets of glacial ice that pushed their way down from Canada during the Great Ice Age, for it was these glaciers that created the fertile prairies of Illinois, where before had been only rough, rocky country, such as still exists in Kentucky and Missouri, and which is unsuited for profitable farming even in boom times. Illinois is the leading agricultural state because of the work of these ice sheets.

Then there are the interesting histories of our extensive

mineral deposits which place Illinois close to the top among the mineral producing states. Few people realize that the value of the mineral products of our State in a single year is greater than the value of all the gold and silver produced in the entire United States, including Alaska, in the same period of time. For each of our important minerals, such as coal, limestone, clay and shale, sand and gravel, fullers' earth, fluorspar, petroleum, silica sand, tripoli, lead and zinc —there is an interesting tale to tell in regard to their origin, accumulation and discovery.

For over 26 years, the State Geological Survey has been accumulating a vast amount of information on the geology and mineral resources of Illinois. This information is available to everyone in the scores of bulletins that the Geological Survey has published since it was founded in 1905.

It is true that most of these bulletins are somewhat technical and therefore in many cases hardly suitable for use in high schools or even by the general public, so that in the past, geologists have had only themselves to blame if the general public was not familiar with their work and with the facts that their researches revealed.

Here in Illinois there are many people who would like to know more than they do about the origin and history of the world around them—there are many teachers who would like to secure authoritative information on these subjects to pass on to their students and there are thousands of high school students who are already interested in such things or who would be if given the proper stimulus.

With this situation in mind, the State Geological Survey recently launched a program of extension work that will make it possible for anyone in the State to learn as much as he wishes to learn about the geology, geologic history and mineral resources of Illinois.

This is what we are doing in carrying out our extension program:

First, we are issuing a number of educational series bulletins, which will reveal in everyday language the main facts regarding geologic conditions in separate local areas throughout the State. Other bulletins in the same series will deal with specific subjects such as "Illinois during the Great Ice Age," "Illinois below the Sea," "The Story of Coal in Illinois," "The Story of Petroleum of Illinois," and many

JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
McHENRY
LAKE
CARROLL
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KANE
DUPAGE
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WHITESIDE
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KENDALL
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LA SALLE
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McDONOUGH
FULTON
TAZEWELL
McLEAN
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SCHUYLER
LOGAN
DE WITT
CHAMPAIGN
VERMILION
ADAMS
BROWN
CASS
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MORGAN
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CHRISTIAN
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LAWRENCE
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WAYNE
EDWARDS
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others. Three of these non-technical bulletins have already been published and are being widely read. In a number of Illinois high schools these Educational Series Bulletins are being used as supplementary reference texts by classes in high school science, physiography and physical geography.

ONE OF THE STANDARD SETS OF ROCKS AND MINERALS WHICH THE STATE GEOLOGICAL SURVEY DISTRIBUTES TO ILLINOIS HIGH SCHOOLS.

The Geological Survey supplies reasonable amounts of these bulletins free of charge when used in this manner. No. 1 of this series deals with "The Rock River Country of Northern Illinois." No. 2 is entitled "The Story of the Geologic Making of Southern Illinois." The title of No. 3 is "Typical Rocks and Minerals of Illinois."

In addition to these Educational Series Bulletins, many of the regular publications and maps are of value for school use. Our complete list (of publications free to schools) will be sent to anyone who may wish to order these materials.

A second phase of the extension program provides for what we are calling "Earth History Field Trips." The State has been divided into six districts in each of which one trip will be held each year, so that teachers, especially, can secure information on the geology of their own local areas, thus aiding them in their teaching. The schedule for the third annual series of these "Earth History Field Trips" will soon be announced.

A third feature of this extension program is the distribution to the high schools of Illinois, of standard sets of Rocks, Minerals and Fossils typical of this State. Each of the specimens is discussed and illustrated in the printed booklet entitled "Typical Rocks and Minerals in Illinois." These booklets, as stated before, are supplied with the sets of rocks and minerals, for student reference study.

Other educational extension projects will be forthcoming since the teachers of Illinois have been quick to take advantage of those already under way. As this new field of public enterprise becomes more and more established the citizens of Illinois will become better and better known as people of

GROUP OF WESTERN ILLINOIS TEACHERS ON ONE OF THE 1931 EARTH HISTORY FIELD TRIPS.

wide general information with pride in their State because of their thorough knowledge of it—of its past history, its present natural blessings and its future possibilities.

GUIDES IN JUNIOR HIGH SCHOOL SCIENCE

By M. G. McFadden,

Roosevelt Junior High School, Cleveland Heights, Ohio.

Two new guide booklets of about eighty pages each have been printed by the Cleveland Heights, Ohio, Board of Education for use in elementary science of seventh and eighth grades. These booklets cover a period of several years' development by science teachers in the Cleveland Heights school system and are not devised for use with any one textbook. However, students may be asked to purchase a reference for home study. These booklets provide for use of a large number of references thus guiding the student in the literature of general science. The ninth grade booklet has not been completed. The course has developed due to the encouragement of Dr. E. C. Grover, Assistant Superintendent of Schools, to make nature and science a functional activity for children.

Units of the three year course of study are based upon: Seasonal science; logical sequence of subject matter; and child appreciation of nature and scientific achievement. Beginnng classes or sections of any one grade work on the same subject matter as the advanced section of the same grade. Thus the work is made seasonal for both groups. The seasonal organization saves the teacher much time in setting up experiments and organizing lesson plans.

Units of the course of study are as follows:

Seventh Grade, Fall Semester

Introduction to Science, 7B, Review 7A	2 weeks
Fall Plants	6 weeks
Air and Atmosphere	3 weeks
Fire and Heat	3 weeks
Plants (and Animals) as Food	5 weeks

Spring Semester.

Introduction to Science, 7B, Review 7A	2 weeks
Earth's Crust	6 weeks
Stars and Planets	2 weeks
Spring Plants	6 weeks
Bird Life	3 weeks

EIGHTH GRADE, FALL SEMESTER.

Insects	5 weeks
Aquatic Life	3 weeks
Uses of Water	5 weeks
Heating and Ventilating	3 weeks
Machines and Tools	3 weeks

SPRING SEMESTER.

Light and Home Lighting	5 weeks
Sound and Hearing	4 weeks
Fungi and their Relation to Man	3 weeks
Bacteria and their Effect on Man's Welfare	4 weeks
Behavior of Higher Animals, Including Man	3 weeks

NINTH GRADE, FALL SEMESTER.

Air and Water	3 weeks
Weather and Aviation	4 weeks
Junior Chemistry	5 weeks
Biology (Human)	7 weeks

SPRING SEMESTER.

Magnets and Magnetism	6 weeks
Electricity	5 weeks
Radio	8 weeks

Favorite references used by students are as follows:

Author	Title	Abbreviation	Edition	Publisher
Bowden	Foundations in Science	Bowden	1931	Blakiston & Sons
Caldwell and Curtis	Introduction to Science	C. & C.	1929	Ginn & Co.
Caldwell and Eikenberry	Elements of General Science	C. & E.	1926	Ginn & Co.
Carpenter and Wood	Our Environment, Book I.	C. & W.	1928	Allyn & Bacon
Clement	Living Things	Clement	1925	Iroquois Pub. Co.
Clement, Collister, and Thurston	Our Surroundings	C. C. & T.	1928	Iroquois Pub. Co.
Hessler	Junior Science	Hessler	1928	Sanborn
Hodgdon	Elementary General Science	Hodgdon	1922	Hinds, Hayden & Eldridge Co.
Hunter and Whitman	Problems in General Science	H. & W.	1931	American Book Co.
Kinsey	Introduction to Biology	Kinsey	1926	Lippincott Co.
Meier and Meier	Essentials of Biology	Meier	1931	Ginn & Co.
Moon	Biology for Beginners	Moon	1929	Henry Holt
Peabody and Hunt	Biology and Human Welfare	P. & H.	1924	Macmillan Co.
Pieper and Beauchamp	Everyday Problems in Science	P. & B.	1925	Scott and Foresman
Smallwood, Reverly and Bailey	New Biology	S. R. & B.	1924	Allyn & Bacon
Tarr and Von Engeln	New Physical Geography	Von E.	1926	Macmillan Co.
Trafton	Biology of Home and Community	Trafton	1923	Macmillan Co.
Van Buskirk and Smith	Science of Everyday Life	Van B.	1931	Houghton Mifflin,
Wheat and Fitzpatrick	Advanced Biology	W. & F.	1931	American Book Co.
Wood and Carpenter	Our Environment, III.	W. & C. (3)	1927	Allyn & Bacon

A small junior high school might easily use this system with a minimum of five copies of each of the ten most important references plus other single volumes for special references.

Few if any general science texts include sufficient biological material. Several of the better biology texts are included for selected material although the texts as a whole may be too advanced in some units. The use of advanced biological references does not detract from the high school course but instead adds anticipation and enjoyment to the course. Such a reference may be used for picture study alone. This type of science study will finally facilitate a more advanced biology course in the high school based more or less on the same work-study plan as used in the general science course. A course of this type cannot be completed in a year but should cover a period of several years' development.

Such a large field of science is covered in the three years' course as will give the student a greater appreciation of the extent or magnitude of science. Change of units every few weeks prevents monotony. Scientific attitude is encouraged by making it easier for the student to help himself. The guide booklet not only guides in subject matter but also guides in possible experiments and projects. Credit is given for individual projects. It is planned to make the first revision of the booklets include more projects, problems and individual experiments.

Greater interest in science is created by preventing loss of time and the resulting impatience due to inabilty to find specific references. Page references are cited for each question or problem.

Each child purchases or is provided with a copy of the guide booklet for his own use. Supplementary materials are being developed by teachers as the guides are being used, anticipating a revision of the guide booklets in another year or so. Additions and changes are being continually contemplated. Each teacher attempts to jot down notes for such as he teaches the subject. Objective tests and more optional problems are being devised.

It is not expected that this course of study and its resulting guide booklets will take the place of high school courses. It is expected that they will create greater interest in science and provide larger enrollment of capable students in high school and college courses.

AQUARIUM PLANTS. THEIR HABITS, AND AN ACCOUNT OF SOME NEW OR LITTLE KNOWN SPECIES OF MERIT

By EDWIN D. HULL,

Hull Botanical Supply House.

The purpose of this article is twofold, first to give an account of the habits of aquarium plants, by which it is believed that a selection of plants and their cultivation may be made more easy, and second to introduce some little known or entirely new species, all of which have been thoroughly tested and found meritorious.

As to habit, two great divisions can first be made, non-evergreen plants, and those which are evergreen.

The non-evergreen plants include only a very small proportion of species as contrasted with those of the evergreen group. These plants last but a single season, forming winter buds in the autumn, when the parent plants die. Such plants include the Common Bladderwort *(Utricularia vulgaris)*, the Water Milfoil or Parrot's Feather *(Myriophyllum verticillatum)*, and one of the Duckweeds *(Spirodela polyrhiza)*. Such winter buds remain dormant in the aquarium until February or sometimes a little later, when they resume growth, always earlier than they would in nature. All these plants are of considerable interest to students of botany, but they are useless if a person desires fully-developed plants during the winter, as, of course, would usually be the case.

Of the second group, comprising the evergreens, five sections can be recognized.

1. Plants rooting in the soil, entirely submerged. These are all plants of considerable size, and they are the best of aquarium plants, being good oxygenators (since the entire body is below the surface), and many of them are quite decorative, with the leaves either finely divided or else ribbon like. Being entirely submerged they are plants of little substance, in spite of their rather large size, and so they do not require a rich soil, in fact, clean sand is sufficient, with perhaps the addition of a few snails, the waste products given off by the animals allowing ample nutrition for the plants. These plants include the Fish Grass *(Cabomba caroliniana)*, probably the most used of all, the Water Weed *(Elodea canadensis)* together with its giant

form, usually known as *Anacharis*, the Water Milfoil *(Myriophyllum spicatum)*, the Tape Grass *(Vallisneria spiralis)*, the White Water Crowfoot *(Ranunculus aquatilis)*, the Quillwort *(Isoetes lacustris)*, and the Pondweeds *(Potamogeton americanus and P. crispus)*.

I. UPPER ROW, LEFT TO RIGHT. HORNWORT (CERATOPHYLLUM DEMERSUM) AND SPIKE RUSH (ELEOCHARIS ACICULARIS). LOWER ROW, LEFT TO RIGHT. CRISPED PONDWEED (POTAMOGETON CRISPUS) AND PONDWEED (POTAMOGETON AMERICANUS).

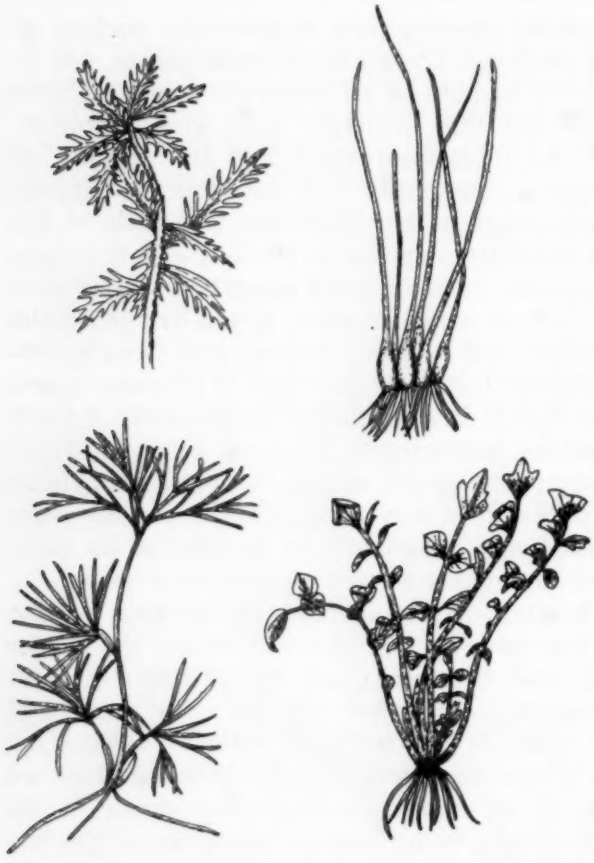
2. Plants not rooting, but resting on the bottom, entirely submerged. This small group includes the Hornwort *(Ceratophyllum demersum)*.

3. Plants rooting in the soil, sometimes entirely submerged, sometimes entirely out of the water, but more often partially raised above the surface, the so-called "amphibious" plants. This group of rather large plants includes the Water Purslane *(Ludvigia palustris)*, the Spike Rush *(Eleocharis acicularis)*, the Water Cress *(Radicula Nasturtium-aquaticum)*, and the Mermaid Weed *(Proserpinaca palustris)*. Such plants, having more bulk, require for their best development a richer soil than would be necessary for the preceding groups.

4. Plants usually floating just beneath the surface of the water, not rooting. These are all small plants, one of them *(Wolffia)* the smallest of all flowering plants. Under favorable conditions they multiply with great rapidity. On account of the submerged habit, and the rapidity of growth and reproduction, they are desirable as oxygenators. A disadvantage is that they leave too little of the surface of the aquarium exposed to the air, and it is perhaps better to grow them in small quantities along with other plants. This is a rather small group, including the Duckweeds *Wolffia* and *Lemna trisulca*, and the Crystalwort *(Riccia fluitans)*, the last of which is of some botanical interest in that it is much lower in the scale of plant life than the others, belonging to the great group in which occur such lowly plants as the mosses. *Wolffia* is of interest in that in nature it is very rare except in certain years when it is exceedingly abundant, but in spite of its usual rarity it grows in aquaria as well as any other plant.

5. Plants floating on the surface, the greater portion raised above the water. This group includes the Water Ferns *(Azolla* and *Salvinia)*, and the Water Hyacinth *(Eichornia crassipes)*. The first two are quite small, and do not at all resemble the ferns of ordinary cultivation, while the last attains considerable bulk. *Salvinia* does not always behave as an evergreen, sometimes dying in the autumn. Such plants, being largely raised above the water, contain much substance, and if the best results are to be obtained a rich soil is necessary, and a shallow pan, in which the roots or root-like organs can be in close proximity to the soil, is more desirable than the ordinary aquarium. Moreover, such plants seem to be affected by the conditions obtaining in an ordinary house much as potted plants would be, and they do better in a greenhouse. Altogether it seems better to grow these plants for their own sakes, if such is desired, as being of considerable botanical interest, than to have them as inhabitants of ordinary aquaria.

Eight species are herewith noted, all of them desirable, but either not known at all as aquarium plants, or so little known as to be worthy of special mention. An attempt has been made to list them in the order of their desirability.



II. Upper row, left to right. Mermaid Weed (Proserpinaca palustris) and Quillwort (Isoetes lacustris). Lower row, left to right. White Water Crowfoot (Ranunculus aquatilis) and Water Cress (Radicula Nasturtium-aquaticum).

White Water Crowfoot *(Ranunculus aquatilis)*. An evergreen plant, like the following species, distributed throughout the north temperate zone, the only portion raised above the water being the white flowers, which will probably not be formed in aquarium specimens. It is a rapid and vigorous grower, and somewhat resembles *Cabomba,* but the leaves are darker green, more finely divided, and alternately arranged on the stem. Probably no aquarium plant is quite as decorative as this. It is found in nature in two entirely different habitats, the one being quiet water, where the plant grows very tall, the other being the swift water of brooks, where the plant is much dwarfed as to length, though the leaves do not diminish in size. These dwarf plants, however, grow rapidly when placed in an aquarium. This is apparently not listed by dealers.

Hornwort *(Ceratophyllum demersum)*. This plant occurs across the continent of North America, also in various parts of the Old World. It does not root, but will sink to the bottom of the aquarium, or the base can be submerged in the sand. The leaves are finely divided, and the entire plant is impregnated with silica, making it rough and rigid. This is a good grower, and is altogether desirable. It is listed by some dealers in school supplies, but is not known apparently to the general trade.

Pondweed *(Potamogeton americanus)*. The pondweeds, comprising many species, are in general short lived in aquaria, but this species and the next seem to be fairly satisfactory. This species has two types of leaves, both entire, but the submerged leaves are long and grass-like while the floating leaves are oval in shape. In the aquarium only leaves submerged and intermediate in shape between the two types have been observed. The veins of the leaves form a conspicuous network, or as one would say in botanical terminology the leaves are "finely reticulated." This species does not seem to be generally known to the trade.

Crisped Pondweed *(Potamogeton crispus)*. This is not native to America but has been naturalized from Europe, extending west as far as Chicago and possibly further. As the name suggests, the leaves, which are all submerged, are crisped somewhat as in a leaf of lettuce, and the plant has a very pleasing appearance. It seems to grow fairly well in aquaria though it grows slowly. This has been listed among school supplies, but does not seem to be known elsewhere as an aquarium plant.

Spike Rush *(Eleocharis acicularis)*. An amphibious plant, occurring across the continent of North America, also in the West Indies and in Eurasia. This is a small tufted plant which would ordinarily be taken for a species of grass. The plant propagates abundantly in nature, but in aquaria apparently not at all, but is very long lived, sending up new leaves from time to time. This is apparently not offered by any dealer.

Quillwort *(Isoetes lacustris)*. This entirely submerged species occurs in the southern United States. As the common name suggests, the leaves resemble quills in shape. Botanically the plant is related to the ferns. In nature it propagates by runners as well as by spores, but in the

aquarium apparently not at all, though in shaded situations it is long lived. This is offered by one dealer in the south, but apparently not elsewhere.

Water Cress *(Radicula Nasturtium-aquaticum)*. This is another amphibious plant, naturalized from Europe. It is well known as a salad plant, but does not seem to be mentioned for aquaria. This is found in the cold water of brooks, and if it can be kept in a cool place the plant seems to do well, otherwise it is not worth while to attempt its culture.

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A BRIEF SURVEY OF THE MECHANICAL FUNDAMENTALS OF HIGH SCHOOL CHEMISTRY TAUGHT IN THE UNITED STATES

By Joseph E. Malin,

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During the course of construction of a diagnostic test in the mechanics of high school chemistry and its related fundamentals, it became necessary to determine which chemistry textbooks and manuals are most widely used in the secondary school field and to determine to what extent the materials selected for the tests are taught.

In order to gain information concerning these points, the writer personally interviewed twenty-five high school chemistry teachers in eastern Pennsylvania and New Jersey. The questions asked during these interviews were formulated into a questionnaire, copies of which were sent in June 1930 to the school superintendents in two of the largest cities in each state of the Union. During September, 1930, copies of the questionnaire were again sent out to school superintendents of one or two cities next larger in size in those states from which only one or no response had been received in June. In all, there were 96 replies representing every state in the Union with the exception of Nevada.

Table I shows the the results of the personal interviews and the questionnaire study of the most widely used chemistry textbooks and manuals in the public secondary schools. The authors' names together with the titles of their texts are arranged in the order of their frequencies from the highest to the lowest in each of the two classifications. The total number of school systems represented in this table is 101.

Table I

Frequency of Basic Textbooks and Manuals Used in 101 School Systems in the United States.

	Basic Textbooks	Frequency
1.	Brownlee, Fuller, Hancock, Sohon, Whitsit: "Elementary Principles of Chemistry"	33
2.	Bradbury, R. H.: "A First Book in Chemistry"	17
3.	Black and Conant: "Practical Chemistry"	13
4.	McPherson and Henderson: "Chemistry and Its Uses"	10
5.	Dull, C. E.: "High School Chemistry"	9
6.	Gray, Sandifur, and Hanna: "Fundamentals of Chemistry"	7
7.	Gordon, N. E.: "Introductory Chemistry"	7
8.	Bruce, G. H.: "High School Chemistry"	4

9.	Greer and Bennett: "Chemistry for Boys and Girls"	4
10.	Dinsmore, E. L.: "Chemistry for Secondary Schools"	4
11.	Fletcher, Smith, and Harrow: "Beginning Chemistry"	4
12.	Irwin, Rivett, and Tatlock: "Beginning Chemistry"	3
13.	Hessler and Smith: "Essentials of Chemistry"	2
14.	Newell, L. C.: "General Chemistry"	2
15.	McPherson and Henderson: "Elements of Chemistry"	2
16.	McPherson, Henderson, and Fowler: "Chemistry for Today"	2
17.	Brownlee, Fuller, Hancock, and Whitsit: "Experiments in the Chemistry of Common Things"	1
18.	Holmes and Mattern: "Elements of Chemistry"	1
19.	Newell, L. C.: "Practical Chemistry"	1
20.	Cook, C. G.: "Practical Chemistry"	1
21.	Kendall, J.: "Smith's Elementary Chemistry and Manual"	1
22.	Holmes, H. N.: "General Chemistry"	1
23.	Gordon, N. E.: "Introductory College Chemistry"	1

	Basic Manuals	Frequency
1.	Brownlee, Fuller, Hancock, Sohon, and Whitsit: "Laboratory Exercises"	18
2.	Teachers prepare their own manuals	10
3.	Bradbury, R. H.: "Laboratory Studies To Accompany 'A First Book in Chemistry'"	9
4.	Gray, Sandifur, and Hanna: "Manual to Accompany 'Fundamentals of Chemistry'"	8
5.	Dull, C. E.: "Laboratory Exercises in Chemistry"	6
6.	McPherson and Henderson: "Course in General Chemistry: Laboratory Manual"	6
7.	Black, N. H.: "Laboratory Experiments in Practical Chemistry"	5
8.	Irwin, Rivett, and Tatlock: "Elementary and Applied Chemistry Manual"	2
9.	Kendall, J.: "Smith's Elementary Chemistry"	2
10.	Greer and Bennett: "Laboratory Manual for Chemistry"	1
11.	Collister and Walbrath: "Laboratory Guide for Chemistry"	1
12.	Boynton, Morse, and Watson: "Applied Chemistry Manual"	1
13.	Williams and Whitman: "Laboratory Exercises in General Chemistry"	1
14.	Dinsmore, E. L.: "Laboratory Manual of Chemistry"	1
15.	Hessler and Smith: "Laboratory Exercises"	1
16.	Bruce, G. H.: "Laboratory Manual of Chemistry"	1
17.	Fletcher, Smith, and Harrow: "Manual for Beginning Chemistry"	1

The general ranking order of the first eight textbooks is not quite the same as that for the manuals. This is to be expected when one notes the frequency of those manuals which are prepared by the teachers. Furthermore, the frequencies for the manuals are not as high as they are for the textbooks. This can be accounted for by the fact that some of the officials in filling out the questionnaires failed to name the manuals although they had specified the basic texts. Although the questionnaires requested this infor-

mation, yet those filling it out no doubt felt that if they did not name the manual it was understood that it is the one which accompanies the text. If this assumption is correct, then the assumed frequencies for the manuals should approximate those of the textbooks.

Two of the high schools used no basic texts but required their pupils to learn their chemistry from six or more high school chemistry texts which are kept in the library or science room. These teachers stated that they preferred that their pupils become acquainted with several sources of information rather than that they should depend primarily upon a single basic text.

The first part of the questionnaire requested information concerning the teaching of eight gaseous elements and compounds: (1) are these topics taught in class? (2) are individual or demonstration experiments performed? Part II requested facts concerning the teaching of the principles of valence, nomenclature, formula writing, equation writing, and the solving of several types of numerical problems together with those laws and definitions which are directly related to the foregoing principles.

Table II presents the data which have been obtained from the responses to the questionnaire and is read as follows: 94 of the 96 school systems or 97.9 per cent of them teach the topic of oxygen; 94 or 97.9 per cent of them also teach the topic of oxygen by means of individual or demonstration experiments. Part II is read as follows: 96 or

TABLE II

Frequency Distribution of Chemistry Topics Taught in 96 City School Systems in 47 States of the Union.

PART I

Topic	Number Teaching the Topic in Class	Number Teaching the Topic by Experiment	Per Cent Teaching Topic in Class	Per Cent Teaching Topic by Experiment
1. Oxygen	94	94	97.9	97.9
2. Chlorine	92	90	95.8	93.7
3. Carbonmonoxide	83	51	86.5	53.1
4. Argon	67	1	70.0	1.0
5. Hydrogen	94	94	97.7	97.7
6. Nitrogen	92	86	95.8	89.6
7. Carbondioxide	94	94	97.9	97.9
8. Helium	77	2	80.3	2.1

100 per cent of the school systems checked the "yes" item in the first question on valence thus indicating that they taught this topic.

PART II

Topic	Number Answering "Yes"	Number Answering "No"	Per Cent Answering "Yes"	Per Cent Answering "No"
1. Valence	96	0	100.0	0
2. Naming chemical formulas	96	0	100.0	0
3. Writing chemical formulas	96	0	100.0	0
4. Balancing chemical equations	96	0	100.0	0
5. Writing double decomposition equations	93	2	97.9	2.1
6. Writing molecular equations	96	0	100.0	0
7. Writingcompletion equations	96	0	100.0	0
8. Writing entire equations	95	1	99.0	1.0
9. Writing oxidation equations	91	3	94.8	3.1
10. Writing reduction equations	93	3	96.9	3.1
11. Writing ions of compounds	95	1	99.0	1.0
12. Writing ionic equations	85	11	88.5	11.5
Problems in finding				
13. Weight of liter of gas with atomic weights given	88	8	91.7	8.3
14. Weight of reagent or product from equation	95	1	99.0	1.0
15. Volume of reagent or product when 1 volume is given	90	5	93.8	5.2
16. Volume by Charles' law	87	9	90.5	9.4
17. Volume by Boyle's law	88	8	91.7	8.3
18. Volume by Boyle's law and Charles' law	88	7	91.7	7.3
19. Formula with percentage composition and atomic weights given	88	6	91.7	6.3
Laws and Definitions				
20. Law of definite proportions	95	1	99.0	1.0
21. Law of conservation of mass	95	1	99.0	1.0
22. Law of multiple proportions	88	7	91.7	7.3
23. Law of Charles	86	8	89.6	8.3
24. Law of Boyle	87	7	90.6	7.3
25. Law of Gay Lussac (combining volumes)	91	5	94.8	5.2
26. Definition of base (ionic)	95	1	99.0	1.0
27. Definition of acid (ionic)	95	1	99.0	1.0

In the case of carbon monoxide, only 53.1% of the schools perform experiments with the gas. The responses to argon and helium are interesting since one would be inclined to expect zero responses in the "experiment" column. The writer feels that these particular responses are authentic, since in the one school the names of each of the four chemistry teachers are given together with the topics which

each teaches. In the second school, helium is taught both in class and by means of experiments while argon is not taught at all. The responses to the same items in the third questionnaire may not be valid since all the items in both columns for the eight gases were checked.

Although these rare gases, argon and helium, are seldom taught by the aid of experiments, yet they are at least discussed in 67 to 77 per cent of the schools. That helium is taught in a higher per cent of the school systems than argon is not at all surprising when one considers the greater and more spectacular use of helium in dirigibles.

In Part II, questions 6-9 and 11-12 contained illustrations of the kinds of equation so that there would be no misunderstanding as to the meaning of the terms. The example for a molecular equation in question 6 was: $2Na+2H_2O=2NaOH+H_2$. The example for a completion equation in number 7 was: $Zn+H_2SO_4=?$ The illustration for an entire equation in number 8 was: the action of hydrochloric acid upon limestone. In question 9, the example for an oxidation equation was: $Cu+HNO_3=?$ This type of reaction although named oxidation in the questionnaire illustrates both oxidation and reduction. The illustration given for question 11 on the writing of ions for a given compound was: $NaCl=Na^+ + Cl^-$. In number 12, $Ag^+ + NO_3^- + H^+ + Cl^- = AgCl + H^+ + NO_3^-$ was given as the illustration of an ionic equation.

In the replies to the first eleven questions of the "yes" "no" type, the per cents of "yes" answers vary from 94.8 to 100 per cent. In a few cases such as in questions 15 and 18 where the totals for "yes" and "no" do not equal 96, this indicates that a few in filling out the questionnaires omitted these items. Four schools qualified their answers to questions 9 and 10 on oxidation and reduction equations by stating that only a few of these equations are taught in their classes.

The responses to 11 and 12 are significant since the writer in the course of the construction of his tests obtained very low per cents of correct responses on those items where pupils were required to write compounds in the ionic form and to write ionic equations. For example, the range of per cents of correct responses for the writing

of electrolytes in the form of ions for 1208 pupils of 12 public schools was from 8.3 to 41.6 per cent while the range of per cents of correct responses for the writing of ionic equations was from .3 to 4.1 per cent.

In the responses on the types of numerical problems taught, over 90 per cent of all the responses were in the affirmative. In the case of question 14, there is almost perfect agreement since only one school returned a negative reply.

The agreement among the schools on the teaching of laws and definitions is very good since over 90 per cent of the school systems teach the items mentioned in the questionnaire.

In the questions on laws and definitions, it is interesting to note that the per cents of "yes" responses on questions 23, 24, and 25 agree very closely with the corresponding per cents to questions 16, 17, and 15. A follower of sound pedagogical principles would expect this result since a mastery of the laws by the pupils would not be complete without a knowledge of their applications, the application in this case being the solving of problems. Applying this same principle, note again the degree of agreement between the per cents of "yes" and "no" responses to questions 26 and 27 on ions and the per cents of "yes" and "no" responses to question 11.

The degree to which the responses to the questions in the questionnaire are reliable is shown by the fact that all 96 questionnaires were signed and that all but four of the signers designated their official positions. Furthermore, if the titles held by the signers are any indication of the degree of responsibility assumed by them in answering the questions, their answers should be reliable. Table III shows the frequency distribution of the official positions of the signers. When the frequencies for the "Head of the Science Department" and the "Head of the Chemistry Department" are added, the department heads will rank first with a frequency of 42.

TABLE III

Frequency Distribution of Official Positions of the Signers of the Questionnaire.

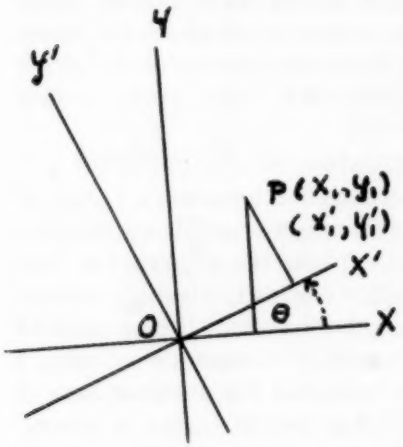
	Position	Frequency
1.	Head of Science Department	32
2.	Chemistry Instructor	30

3.	Head of Chemistry Department	10
4.	Superintendent of Schools	10
5.	Principal of High School	4
6.	Official position omitted	4
7.	President of Junior College	1
8.	Supervisor	1
9.	Supervisor of Chemistry	1
10.	Second Assistant Superintendent	1
11.	Director of High Schools	1
12.	Dean of the Faculty	1
	Total	96

A METHOD FOR DERIVING FORMULAS OF ROTATION

By ROBERT G. FUSSELL, *Student State Teachers College, Flagstaff, Arizona.*

Formulas for the rotation of rectangular axes may be derived by making use of the formula which expresses the distance from a line to a point. Let θ be the angle of rotation measured from the $x-$axis. The equation of the $x-$axis in terms of the primed coordinates is $y' = -x'\tan\theta$. The equation of the $y-$axis is likewise $y' = x'\cot\theta$. We now use the distance formula



$$d = \frac{Ax_1' + By_1' + C}{\sqrt{A^2 + B^2}}$$

to obtain the values of x_1 and y_1. We find

$$x_1 = \frac{-x_1'\cot\theta + y_1'}{\sqrt{\cot^2\theta + 1}},$$

$$y_1 = \frac{x_1'\tan\theta + y_1'}{\sqrt{\tan^2\theta + 1}} \text{ or } x_1 = x_1'\cos\theta - y_1'\sin\theta \text{ or } y_1 = x_1'\sin\theta + y_1'\cos\theta.$$

ILLINOIS STONE AXES MAY BE 4,000 YEARS OLD

The ancient history of Illinois may be pushed back to 2000 B. C., if a chance archaeological discovery by highway workmen proves the good clue that it appears to be, Prof. A. R. Kelly of the University of Chicago, stated recently at Champaign.

Workmen excavating a culvert near Henry, Illinois, dug up two flint axes and an arrowhead, the leg bone of a deer, and some ashes and charcoal, all buried nine feet deep. The discoverers casually carried off the relics, and so disturbed the site that scientists can not be sure of its significance. But Dr. Kelly and Dr. George Eckbau, of the State Geological Survey, examined the road cut and reported that the soil under which the relics lay buried appears to be a deposit some four thousand years old.

Scientific excavations in the Illinois Valley near the site will be rushed in the hope of further discoveries, particularly in the gravel and sand pits of the bluff which are known to belong to the Pleistocene Age of geological history, Dr. Kelly stated.—*Science Service.*

RATIO OR CONCRETE QUANTITIES?

By Warren C. Hawthorne,
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I think it was about thirty years ago that a wonderful pedagogico-mathematical discovery was made which proved that all teaching up to that time was in error. This was that all number is a ratio, and should be so taught. Not being interested in elementary education at that time, I can not speak definitely, but I think it resulted in (or was it the effect of?) a series of arithmetics, by which the delicate mind of the child was supposed to be nurtured on "pure number." A similar experiment was tried at one time on some aseptically hatched chicks, which were fed on pure, bacteria-free food. I think the results were about the same in both cases. I know that when the chicks died, which they obstinately did at extremely early ages, their insides were found quite germless.

Unfortunately, similar verification of the purity of our pupils' minds is not so easy, though I have seen frequent symptoms of such a condition among my pupils in physics. When a boy who is asked to explain the expression "the specific heat of aluminum is 0.22," begins to stumble around in a tangle of words like "the ratio between the amount of heat required by a certain amount of aluminum—" etc., I sigh as I reach for the braces intended for another case of mathematical rachitis caused by a diet of "pure number."

It is easy for the mathematician to deal with "pure number." He would not have taken to mathematics in the first place if he had not had that kind of a mind. But as a teacher he should remember that this ability is rare. Say "five" to the ordinary person and he thinks "five dollars," "five men," "f-i-v-e" or "5," and I am convinced that nine-tenths of the pupils who come to me for physics think only "r-a-t-i-o" when they use that word. I base my belief on the fact that so few of them are able to use the idea (or a definition involving the word) in any kind of a practical problem, even if they are able to reel off the definition of some physical constant as a *ratio*.

I believe we are committing a grave mistake if we attempt to teach the constants of physics as ratios. They are concrete not abstract numbers, and the pupil should never

be allowed to forget it. Specific heat is the *heat,* measured in calories, needed to raise the temperature of one gram one degree. Young's Modulus is the *force* needed to stretch a bar of unit cross section to twice its original length (or give it 100% elongation) supposing it to remain perfectly elastic. "Stress divided by Strain," or worse still "Stress *over* Strain (who invented that abomination?) means nothing practical to the healthy boy, except that it is easy to say, and if rolled off glibly may save him from further quizzing. We are accustomed to think that "specific gravity" must be defined as a ratio to distinguish it from "density" but the distinction would never have arisen had we been satisfied with the word "weight." "Specific weight" conveys the same concrete meaning as "density." Incidentally, how many other false ideas have crept into popular thinking under cover of this Latin synonym of a perfectly respectable Anglo-Saxon word; "the force of gravity," "Bodies fall because of gravity," etc.

A remark made by the late Dr. Geo. W. Myers, of the mathematics department of the University of Chicago, will bear frequent repetition: "We may multiply anything by anything else, provided we give the correct name to the answer, and provided the name means anything." Whether the answer means anything or not depends upon convention. We do not multiply seven tables by four chairs because the answer "twenty-eight chair-tables" does not mean anything at present. Some one may give it a meaning tomorrow which will sound logical enough to be generally adopted, and the operation will be no more unreasonable than the multiplication of seven pounds by four feet. Every one knows what is mean by "twenty-eight foot-pounds of work." Similarly, the division of six dollars by twelve books offers no difficulty to either clerk or buyer. The answer is "half a dollar per book" and we all interpret it as "the price of one book." Or twelve books may be divided by six dollars, and the answer, "two books per dollar" needs no translation to any one capable of understanding English.

Notice that these answers consist of two parts: the numeric or pure number, and the dimensional or name part, e.g. "books per dollar," usually written "books/dollar."

The only question is, as said before, "Does the answer

mean anything?" What any symbol means is a matter of convention. "Mamma," "papa" among English speaking people are feminine and masculine respectively; among certain tribes in South America the contrary is the case.

Moreover, a symbol may take on additional connotation, which is perfectly allowable, provided there is no contradiction between the old and the new meaning. To the fourth grader, addition means getting a result numerically larger than the parts. The ninth grader learns to add negative numbers which make the sum smaller. About that time he learns the meaning of exponents, which indicate "the number of times a quantity is taken as a factor." Then he runs across the expression "n-¾" and has to learn a new meaning—an extension of the old.

We should see to it that our pupils in physics take another forward step, and enlarge their conception of quantity by adding the idea of dimensions to that of magnitude. The answer "17" is incorrect if "17 inches" is meant. Beginning with these simple things, they should be trained to think of density as "gms/cm^3," "lbs/ft^3," etc., pressure as "dynes/cm^2," surface tension as dynes/cm," and so on, depending on the units used. This having been learned, their attention should be called to the fact that these dimensions can be treated exactly like other literal quantities,—multiplied, divided, "cancelled out," etc. For example:

$$30\ \frac{\text{Miles}}{\text{hour}} = \frac{30\ \text{mi.} \times 5280\ \text{ft/mi}}{1\ \text{hr.} \times 3600\ \text{sec/hr}} = 44\ \text{ft/sec.}$$

the dimensions of the answer being obtained by cancelling miles from the numerator and hours from the denominator.

A careful watch of the dimensions involved in a problem is necessary for the avoidance of blunders. In a recent quiz the following question was asked: "What is the acceleration when a car attains a speed of 30 mi/hr in 22 sec. from rest?" This was one solution: "a=v/t=30/22=1.36" obviously correct, even though awkward, if due regard had been given to the name of the result, "miles per hour per second." But the next question was, "How far did it go in this time, and the solution was, "s=½ at ^{2}=½ x 1.36 x 22^2= 329+ft." The pupil probably put it "feet" merely because

a gleam of common sense told him that it couldn't be miles.

Now suppose he had followed directions and used dimensions throughout in this last problem. He would have written "$s=\frac{1}{2} \times 1.36 \frac{\text{miles}}{\text{hrs. sec}} \times (22 \text{ sec.})^2 = 329 \frac{\text{mi. sec}}{\text{hour}}$", meaningless as it stands, but reducible to miles if we multiply the numerator by 3600 sec/hr and reduce, or to feet if we also multiply the denominator by 5280 ft/mi. Of course if the student had had brains enough to do this, he would have seen that his first answer was not in its simplest form and could be reduced to "2 ft/sec²" by perfectly rigid arithmetic; or more likely he would have changed his 30 mi/hr to 44 ft/sec in the first place, and thus he would have obtained an acceleration of 2 ft/sec² directly.

Numerous cases like this occur in the course of a term's work but "this is an exercise that will be left to the reader."

Nothing in this article should be construed as implying that the primary pupil in mathematics should be confused by too much attention to dimensions. But on the other hand, too strenuous insistance that "all number is ratio" is simply inculcating habits of thought that have to be unlearned later when the student has to deal with new and unfamiliar concrete numbers. Even for the student of high school physics clarity of thought and expression is induced by insisting on the use of dimensions, and in a second article we shall try to show some additional values in more advanced study.

RED LIGHTNING DECEIVES AS FIRE WARNING

White lightning, which flashes down through dry air where no rain is falling, is much more likely to start a fire if it strikes a building or a tree than is red lightning, which flashes through rain that has already wet what the lightning is about to strike.

Before the meeting of the American Meteorological Society at New Orleans, Prof. W. J. Humphreys of the U. S. Weather Bureau explained why incendiary lightning signals its danger with a white glare, while lightning less likely to start fires glows red. Both types are fundamentally the same; both are electrical discharges through the atmosphere. But a discharge through dry air has only the air gases—oxygen and nitrogen—to render glowing hot; and these always shine with a white light. Lightning that passes through the rain breaks some of the water apart into hydrogen and oxygen, and the characteristic color of incandescent hydrogen is red. Hence the lightning's paradox, of red meaning the less danger.—*Science Service.*

GELATINE CAPSULES FOR "OSMOSIS" EXPERIMENTS

By Jean Broadhurst,

Teachers College, Columbia University, New York.

Gelatine capsules may be used to illustrate differences in permeability in cell membranes for classes in elementary biology and physiology. Although, as indicated later, these capsules are too permeable to afford complete parallels for osmosis and dialysis, they are so inexpensive and so easily set up in experimental form that this brief description of their use seems warranted. Another point in their favor is that these capsules seem much more like cells to the pupils than the usual osmosis apparatus, which utilizes bags made of fish bladders, gold beater's skin or glass tubes with a membrane fastened over one end.

Half capsules are best adapted for individual student use, each capsule being fastened upright in a little dish or other receptacle, such as the metal cap used on bottles of catsup, ginger ale, etc., by first touching its base lightly to the surface of a drop of glue or melted gelatine, starch paste, etc. Into the half capsule we may place substances which have decided affinity for water, such as molasses, table sugar, salt, etc. A good range of situations may be obtained with three capsules containing, respectively, 1. Molasses; 2. Gelatine (or jello) with salt or sugar, and 3. Starch with salt or sugar.

After water is added to the dish, the capsule swells noticeably and the level in the tube falls because of the increased size of the inner cavity. In two or three hours, however, sufficient water will pass into the capsule to make evident the inward passage of water. At the same time, outward passage may be demonstrated by noticing the brown coloring matter or by tasting the sugar or salt in the water surrounding the several capsules. Coffee, copper sulphate and mercurochrome may also be used to show the passage of coloring matter.

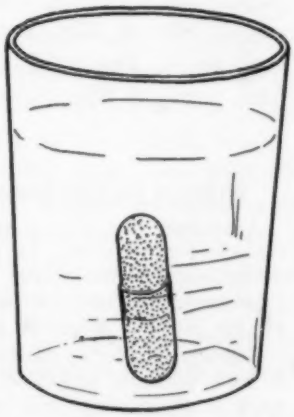
We may reverse the general arrangement just described, placing water in the capsule and molasses, etc.,

outside, to illustrate the passage of water out of a cell and salts, etc., into the cell, if we remember that the swelling of the capsule gives us a false idea of the rate of water movement.

Cane sugar does not ordinarily pass through cell membranes as cane sugar, but it does pass through these capsules slowly. However, differences in cell permeability may be illustrated by comparing starch and sugar; and the inability of starch to pass through the capsule may be shown by adding a drop or two of iodine solution to the water surrounding the starch capsule, and noticing that the usual blue starch-iodine reaction does not occur.

Once the capsules have been used in such experiments, they may be allowed to dry or harden in the bulbous form, which they tend to assume, rinsed with water to clean off dust, and used again by adding more of the original materials. On such repetition, we do not have any marked change in capsule size and form, and the results are, therefore, more comparable to those obtained with ordinary cell membranes. Salt tends to disintegrate the capsules, and with strong solutions they may break down in a few hours; salt capsules can not be reused, usually.

These capsules are so cheap (but a fraction of a cent each) that each child may set up a series for himself. Even at retail druggist prices (ten cents a dozen), many children will enjoy purchasing capsules to try out substances obtainable at home, such as coffee, tea, fruit juice, etc.



The best imitation of a cell, however, is obtained by using a whole capsule, filling it under a liquid to avoid enclosing air. If one-half of a capsule is first filled with sugar, molasses or starch both halves may be immersed and fitted together under water. Since the gelatine capsules swell quickly, we have found it best to moisten or immerse the outer half before the other, so it will be slightly softer and larger than the in-

ner one and therefore slip more easily over the inner half.

If sufficiently concentrated material is used in the capsule, the inflow of water will compensate for the swelling of the capsule itself, and we obtain an enlarged turgid cell which makes a very good model of a cell. If slightly warm table gelatine is used inside the capsule, it seals the joints as it cools and makes a better "cell." Sealing may be secured, also, by dropping the filled capsule into cool but liquid gelatine or by lightly brushing the joint with gelatine after the capsule has been put together. Good results, however, may be obtained with molasses, sugar, etc., without any special seal. For such whole capsule "cells" we find a little larger heavier capsule desirable and our best results were obtained with Parke and Davis No. 13 capsules, which come in boxes of 100, at about $1.50 a box.

Teachers who have been disappointed many times in osmosis experiments due to carrots that leak and fish bladders that develop invisible perforations may like to try these simple cell experiments.

An interesting variant is obtained by filling a series of halves of capsules with different substances, and fitting them together, one closed rounded end fitting down into the open end of the other, to show the passage of the coloring in coffee, molasses, etc., into adjacent sections or "cells." In such cases the pupil sees for himself the individual cells we describe to him in explaining why the molasses or sugar column rises in the well-known carrot experiment. The smaller cheaper capsules (No. 000, about 50c or 60c a hundred) may be used for this, as well as for the half capsule experiments described in the first part of this paper.

WOULD BUILD HIGHWAY INTO GREAT SMOKY PARK

American pioneers who crossed the Great Smoky Mountains in the early days would be honored by a memorial highway from the Great Smoky Mountains National Park to the city of Knoxville, Tennessee, by the terms of a joint resolution introduced in the Senate by Senator Kenneth McKellar, Democrat, of Tennessee.

Senator McKellar states that access into the Great Smoky Park is now difficult, and that highways should be built as soon as the park is completely laid out and ready for the public.

THE TYPES OF ACTIVITIES WHICH SCIENCE STUDENTS PREFER *

By ELIZABETH G. SICHLER,
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Students in secondary schools, the Junior High School, particularly, are constantly being offered activities of various types in both the regular class-room procedure and in extra-curricular activities. This is strictly in accordance with the ideas sponsored by educational authorities who hold that one of the primary functions of the Junior High School (and the developing cosmopolitan High School) is the enrichment and broadening of the students. As yet, however, little discrimination has been shown as to the types of activities offered to students of different levels of intelligence; it is not known what types of activities the groups of different levels really prefer.

Suppose, for example, that you have a group of low-caliber boys who will never graduate from High School. They are studying birds, and to hold their interest you wish to give them some activity which will both entertain and instruct them, something that they are capable of and hence will enjoy doing. These groups seem to be very numerous in the schools of today and they are always a problem. In the furtherance of your aim, described above, shall you ask them to give reports, to copy pictures or to write a story or play based on the life of the robin? You will not, to be sure, expect an overture with the robin's song as the theme, or another composition like *The Blue Bird* from another Maeterlinck to result from your request. But which of the above simple activities would you expect them to prefer? You may have some sound pre-knowledge based on your experience, but you have little objective data to help you in making out your list of activities.

There is a belief current in many quarters that the higher types of intelligence prefer activities which are original, or creative. It was the hypothesis of this study that the majority of the students in the A (and perhaps B) groups would prefer creative activities to those which were merely reproductive. Not everyone agreed with this view. Dr. W. G. Bergman, of the Research Department

*The substance of this paper was read before the Thirteenth Annual Educational Conference, Detroit, in May, 1931.

of the Detroit schools, who kindly acted as a consultant on this problem, opined that the brighter students would know better than to imagine that they could do anything original.

It was thought, nevertheless, that an attempt to determine the truth of the matter, even though the limited scope of the operations made the result only tentative, should be of value to teachers in that it would offer them some relatively objective data on which to base a determination of the types of activities they would offer in their classes and clubs. As the work was done with science students, the results, and projects undertaken, should be especially helpful to science teachers. They should also be an interesting answer to the belief stated above, that the higher types of intelligence, as we rate them, prefer creative activities.

Such a study as this might well come under the topic of character education because the activities in which one engages voluntarily are an integral part of one's character and the education of character will take place when these activities are suitably directed, not more or less haphazardly, as a present.

It is, of course, not necessary to enlarge upon the importance of character education in present-day America. This is amply sustained by the 1932 Yearbook of the Department of Superintendence of the N. E. A. It is hoped, therefore, that in attempting to answer the hypothesis, that the higher typer prefer creative activities, the lower types reproductive activities, this study will prove to be a small contribution to a topic about which much has been said, little done.

Sources of Data

A list of twenty-eight activities which are more or less common in appreciative subjects (and let us not forget that science is an appreciative as well as experimental subject) was compiled. This list, which follows, was sent to eight different teachers in the department with the following request: Please place a *C* after the activities listed here which you consider *Creative,* an *R* after the ones you consider *Reproductive.*

The following definitions were given to the two terms:

1. Creative: an activity involving some original effort.

2. Reproductive: an activity reproducing (copying) something already done.

This is the list which was submitted to them for rating according to the definitions:

TABLE I

1. Perform an experiment without teacher's help.
2. Collect materials for a booklet from magazines, etc.
3. Draw pictures on subject being studied.
4. Sketch pictures on subject being studied, free-hand.
5. Copy pictures already existing on subject studied.
6. Copy pictures from originals on subject studied.
7. Make an original diagram of subject studied.
8. Copy diagrams and figures from texts.
9. Collect and mount pictures from magazines, etc.
10. Collect and mount newspaper articles.
11. Make carvings in soap.
12. Give a floor talk on information gained from reading.
13. Dramatize the subject.
14. Make miniature theatre sets for plays on subject.
15. Write a story based on the subject.
16. Write a report from books in the library.
17. Make maps.
18. Cardboard and paper construction.
19. Make posters.
20. Put original drawings on the board.
21. Look up experiments on the subject.
22. Wood construction (making bird houses, germinating boxes, etc.).
23. Make collections (insects, flowers, etc.).
24. Prepare exhibits from collected material.
25. Prepare material for exhibits.
26. Build object from collected parts (radio, wireless).
27. Answer questions in notebook.
28. Trace Comstock outlines.

A. Why I chose no.....

B. Why I chose no.....

The teachers proceeded to rate this list, with only minor disagreements, as follows: sixteen of the activities were rated creative, twelve of them reproductive. A few of the items were rated differently from the way the writer would have rated them. For example, looking up experiments on the subject being studied was rated as reproductive by the majority, while wood construction was considered creative. On the whole, however, most of them were rated according to the general idea of what constitutes creative and reproductive activities.

This list of activities, without the definitions or ratings was then mimeographed for two classes (Table I), a high and a low group respectively, with the purpose of comparing the two groups according to the criteria of choice, creative and reproductive.

The technique to be employed was that of sampling. If the distribution for the bright and dull groups was not significant, it was the writer's intention to continue until a sufficient number of groups had been examined to make the result reasonably sure. As twelve classes were under the writer's instruction, it was possible to personally examine at least a round dozen of General Science classes.

It is hardly necessary to remind you that the experimenter was not working to prove anything. A hypothesis had been tentatively set up, to be sure, but there was no particular issue at stake. We science teachers tell our students that the true scientific spirit is willing to accept any outcome, no matter whether the hypothesis is proved or disproved. Such was the case in this study.

The classes were told that they would have a Program on a specified future date and that they were to make a selection from the lists, which were then passed out. Each student examined the list and made a selection, which he checked. He wrote his name, age and home room number at the top of the sheet and, beneath, stated his reason for his choice (Table I), and they were asked to be frank. With the first two classes to be examined, this procedure was followed over three or four units. At the close of each unit the Program was given with many evidences of enjoyment and interest. The effect was that of enrichment of the course.

The next semester, as the distribution was not considered sufficiently significant, the sampling was continued with nine more classes. To effect economy of paper, more sheets were not mimeographed, but the marked sets were submitted to these nine classes and the same information was written on separate sheets of paper. The two sets of mimeographed sheets and the nine sets of separate papers were the sources of all the data which follows.

Presentation of Data

The following chart presents the different classes, their ratings, ages, the number of reproductive and creative items selected by each class and what percentage of the class made a majority choice of either reproductive or creative activities.

TABLE II

Grade	Average Rating	Ages	Reproductive	Creative	%
9A	B—	13, 14	15	19	57.3
9A	B—	13, 14	23	17	57.5
9B	C	13, 14	14	17	54.5
9A	B	14, 15, 16	12	23	67.5
9A	A—	13, 14	104	43	70.7
9A	A	13, 14	17	19	53.0
9A	A—	12, 13	19	14	57.5
9B	A—	12, 13	25	14	64.1
9A	C+	13, 14	32	8	80.0
9A	D	15, 16, 17	15	10	60.0
9A	C	14	114	32	78.3

Observing this chart from the left column, we note that the classes dealt with were all ninth grade, the majority being 9A's. We see that all ratings are represented, from A's to D's (which, incidentally, were an all boys class of truants). The majority of the students were thirteen and fourteen years of age. The number choosing reproductive or creative activities is given under each heading, with the percentage of the majority choosing either one or the other in the right hand column.

Looking down this percentage column we note at once that there was no strikingly decisive choice. Although quite explainable by reasons other than those of native capacity, the issue in most of the cases was decided by only a little over half the class. In other words, with a few exceptions, it was almost a fifty-fifty division, with too slight a predominance in either direction to give it much significance. But perhaps this is one of the things that ought to be known—whether there is such a great difference in the types of activities preferred by high and low intelligences as we would be popularly led to believe.

There are several explanations for these results which might be advanced, aside from native inclination towards one type of activity or the other. For example, the large percentage of reproductive activities in the 9A class which stood 104 to 43 was due to a sudden wave of enthusiasm for tracing Comstock Outlines during the unit on fish, which swept contagiously over both classes. Yet, in the last class, a C group, the number of those choosing the same activity was slightly higher. The difference is not as great as the differences in intelligence, as we rate it, would lead us to expect. Such a condition as the contagion just described is likely to occur occasionally with students of this age

and forms a characteristic part of the picture.

It will be noticed that the one highest (A) group and the one lowest (D) group bore out the hypothesis, though not by any great majority. The highest group chose fifty-three percent creative activities, the lowest chose sixty percent reproductive activities. To follow these two extremes further, a selection about twenty "D's" and "E's" and the same number of "A's" was made at random from various groups and the two groups were again compared. From the low group, four chose creative activities and seventeen chose reproductive activities, while the high group showed a total of twelve creative activities selected as against eight reproductive activities.

In view of these results, and as a matter of interest, the home room teachers of all these classes were asked to select two people in their home room who would be considered among the most troublesome from a disciplinary standpoint. The home room teachers were selected for this rating because they are best acquainted with the general standing of the students in this respect.

The papers of these students (all boys) were abstracted from the different groups and their choices totaled as follows: nine creative activities were selected as against fifteen reproductive activities. Most of these boys were of low I. Q. Some of the teachers of the higher groups did not nominate anybody, feeling that no one was sufficiently outstanding in this respect!

These results bore out the previous ones, that students of low intellect tend to prefer reproductive activities, and to this extent the hypothesis was borne out. The percentages, however, were so nearly equally divided that we must interpret the results as meaning that the intellectual rating of any group does not necessarily determine the type of activities its members will prefer. Other factors besides native inclination towards one activity or another enter in, such as that of previous schooling and imitation of others.

In an endeavor to find out what these other factors might be, the reasons given by the students for their selections were inspected. Time and space do not permit here a description of the reasons given by students for their choices, although they do throw some light upon the results.

It can only be said here that they were various and frank. Perhaps the two commonest reasons were, "Because I like to do it," or, "Because it is easy." (And, incidentally these are native inclinations, springing from character.)

A study was made, however, of the most popular choices. They are shown in Table III, following.

TABLE III—THE MOST POPULAR SELECTIONS

Subject	Number Chosen	Creative or Reproductive
Writing reports from books in library	154	Reproductive
Collecting and mounting pictures	35	Creative
Collecting material for booklet	35	Reproductive
Tracing Comstock Outlines	33	Reproductive
Making collections (Insects, flowers)	28	Creative
Making posters	27	Creative
Floor talk	23	Reproductive
Draw pictures from text	21	Reproductive
Collect newspaper articles	20	Creative
Make maps	7	Creative

These are the ten most popular choices. Although you may not agree with the ratings the majority of teachers gave them, you will notice that they just balance, five creative and five reproductive activities. This somewhat bears out Table II, which shows that in most cases the choices are almost evenly balanced. We have tried to explain this by pointing out that the nature of these activities is such that they are the kind of thing most frequently done in other classes, such as Social Science and English.

CONCLUSIONS

We need not necessarily conclude from the evidences of these data that the effect of our schooling is too levelling and that native inclination is almost smothered by other factors which, except in the opposite extremes, divide the classes almost evenly as to preference for creative or reproductive activities. It is true that by the time they reach this age the students have become accustomed to certain kinds of activities and choose them because they have become easy. But while we admit the effect of previous training and ease of accomplishment, the extreme cases show us that native liking or impulse, if strong enough, can be the determining factor.

That preference is almost evenly divided is shown both by the percentages and the ten most popular selections. The preference for either type of activity is not limited to

high or low groups, as Table I shows. There is, nevertheless, a tendency for the highest classes to prefer creative activities and for the lowest classes to prefer reproductive ones, as the study of selected papers showed. This also suggests that this study, having been made of groups, presents the picture in but a blunt outline and that a study of individuals would be interesting.

The data as obtained in this study do not allow us to set up any fixed criteria for the types of activities to be offered to students. They seem to suggest that the average student should be allowed to select his own activities and that his choice will be based on a number of factors beside native ability, such as previous training and ease of accomplishment. With regard to the student who is of extreme brightness or dullness, however, the findings indicate that where this polarity of individual differences is involved, the type of activity to be offered to the one is that which will bring out his ability to create while the other should be encouraged to engage in types of activities which allow him to emulate the best that exists.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE

By Duane Roller,

The University of Oklahoma, Norman, Okla.

A great deal of the joy of life consists in doing perfectly, or at least to the best of one's ability, everything which he attempts to do. . . . The smallest thing, well done, becomes artistic.—*William Mathews.*

It is a matter of social significance that many discoveries and inventions are made almost simultaneously so that it is difficult to award primary credit for the deed. It is proof of the social preparation for even the most outstanding individual achievements.—*Norman Thomas, in "America's Way Out."*

This habit of attaching names to laws, physical methods, or instruments, where the law, method or instrument can be equally well described by some descriptive name, is not one that should in general be encouraged. Personal names are not merely stumbling-blocks to the student, but—and this is my main objection—they often establish false scientific history.—*Arthur Schuster, "The Progress of Physics."*

Logical consequences are the scarecrows of fools and the beacons of wise men.—*Thomas Henry Huxley, "Animal Automatisms."*

People are generally better persuaded by the reasons which they themselves have discovered than by those which have come into the mind of others.—*Blaise Pascal, "Thoughts."*

HOW TO STUDY ALGEBRA

By ESTHER E. REESE,

University of California at Los Angeles

The purpose of this study is to collect as many different aids, devices, and methods as possible to help solve the major difficulties which students have in studying algebra. It is to be noticed that the purpose of this particular study is not the evaluation of such methods but the gathering of them from every available source. In order to do this, the job analysis type of procedure was followed. For a description of this method of work the reader may consult Dr. Crawford's book, *The Technique of Research in Education.*[1] The chief sources of information were: (1) past experience of the writer as a student, (2) experience as a cadet teacher, (3) observations of class work, (4) observations made in study halls, (5) interviews with thirty-two teachers of mathematics, and (6) study of written material.

The major difficulties with a few of the outstanding methods of solution are given here. In the original study there are given two hundred and sixty-one methods of solution of the nine major difficulties.

I. HOW TO GRASP NEW ALGEBRAIC CONCEPTS

1. Look up any unfamiliar words used in the explanation of the concepts.

2. Deliberately make yourself study the explanation in the text. Do not skip over to the problems first.

3. After you have studied the explanation of a new concept given in the book, close the book and write an explanation in your own words.

4. Make up algebraic examples illustrating the concept.

5. See if you can explain the new concepts to another person.

6. Practice with the symbolic notation whenever you have an opportunity.

7. Remember that the symbolic notation is for your convenience in solving problems. Consider it as a device

[1] C. C. Crawford, *The Technique of Research in Education*, Los Angeles, University of Southern California, 1928, Chapter VIII.

to keep the mind free from reference to particular quantities.

8. Think of an equation as a balance of some kind.

9. Remember that the opposite of anything which is called positive must be negative.

10. Make a list of all the different cases which involve the idea of a negative quantity.

11. Grasp the relative values of negative numbers through the number scale.

12. Think of addition and subtraction with negative numbers in terms of money.

II. How to Master Difficult or Complex Processes

A. *General Suggestions:*

1. Be sure that you understand the fundamental steps involved.

2. Master each new principle completely as it is presented.

3. Do not learn each principle as an isolated unit.

4. Examine the signs, abbreviations, and symbols to know what instructions are given.

5. Do one step at a time until accuracy and mastery are assured.

6. Remember that most complicated processes are nothing but a succession of simple steps involving but one principle at a time.

7. Break a complicated expression up into its parts. Drill on the individual steps.

8. Practice on easy combinations.

9. Do not take two or more steps at once until correct work and sufficient practice justify the omission of steps.

10. Connect each new process with certain standard problems until the procedure becomes familiar to you.

B. *Parentheses:*

1. Always look carefully at a parenthesis in order to see what you are told to do with the terms within it.

2. Carry out the instructions indicated by the symbols before the parenthesis instead of merely removing the signs.

3. When removing a parenthesis which is preceded by a minus sign, change the sign of each and every term in it.

4. Practice putting terms into a parenthesis as well as taking them out.

5. Remember that when two or more numbers or quantities are enclosed in a parenthesis, they must be used as one quantity.

C. *Factoring:*

1. Think of factoring as the reverse of multiplication.

2. Practice factoring numbers to become familiar with the idea.

3. Practice recognizing such standard type forms as $a^2 \pm 2ab + b^2 = (a \pm b)^2$; $a^2 - b^2 = (a+b)\ (a-b)$.

4. Encircle each term which is a perfect square; underline the terms which go together to aid in finding the factors.

5. Make a chart to aid in factoring problems.

6. Remember that readiness in factoring is largely a matter of correct practice.

D. *Special Products:*

1. Determine the number of terms.

2. Always use the same order in multiplying so to be sure not to miss any products.

3. Decide what the signs will be.

4. Label the terms until confidence and accuracy are guaranteed.

5. Learn both the algebraic formula and its statement in words.

6. Remember that there are four parts to each term of an expression: the sign, the coefficients, the bases, and the exponents.

E. *Fractional Equations:*

1. Decide what processes you are going to use.

2. Write the directions for each step to be taken before actually working the problem.

3. As you work a complicated fractional equation, make marginal notes showing what steps were taken.

F. *Simultaneous Equations:*

1. See which variable is the easiest to eliminate.

2. Decide which process to use to eliminate the desired unknowns.

3. Recognize the equations of the straight line and circle.

4. Make a table of values for the unknowns which satisfy the given equations.

III. How to Set Up Equations for the Solution of Problems

1. Make a systematic study of words and their algebraic translations.

2. Divide the statement of the problem into phrases.

3. Practice translating each phrase of the statement into algebra.

4. Read the problem through once to get the idea of the problem as a whole. Do not pay attention to the numbers given.

5. Determine the number of unknowns to be found.

6. Pick out the quantity about which the least is known.

7. Be sure to do exactly what the problem wants.

8. Suggest possible solutions. From these choose the suggestion which is most direct.

9. Make an accurate and detailed analysis of the problems to be solved by means of a table or chart.

10. Make a sketch, diagram, or graph to illustrate the given or involved relationships.

11. Master the technique of solving a certain type of problem before attacking a new type.

12. Form a plan of action.

13. Follow up any clues which may suggest possible solutions; jot down ideas on a piece of paper.

IV. How to Improve Accuracy and Speed in the Fundamental Operations

1. Review and drill on the four processes of arithmetic until they become automatic.

2. Practice combinations in different orders.

3. Do not depend on paper and pencil; work without them.

4. Do not combine steps at first.

5. Always work for accuracy before speed; acquire speed gradually by degrees.

6. Practice for speed by timing yourself on the oral exercises.

7. Concentrate and drill on one type at a time.

8. Drill especially on the operations in which you are weakest.

9. Learn the law of signs.

10. Be sure to do the indicated operations in the proper order.

V. How to Check Work

1. Check an operation by using another operation which tests the correctness of the first.

2. Check any operation by performing it twice.

3. Use short methods to check long methods.

4. Think your proposed solution through and check it for convenience as well as correctness.

5. When in doubt about the validity of a step, check by substituting numbers.

6. Check your interpretation of a worded problem by substituting your result in the statement of conditions of the original problem to see if they are fulfilled.

7. Estimate your answer and then see if the solution obtained agrees fairly well with it.

8. Start over on a new sheet of paper instead of going over the previous solution.

9. Check the addition of quantities of unlike sign by adding the positive and the negative ones separately and then finding the algebraic sum of the two results.

10. Check the squaring of a trinomial by grouping it in a different way.

11. Check to see that roots have not been added or lost.

12. Do not assign the value of one to the unknown when powers of the unknown are involved, since the exponents will not be checked.

13. When checking work in fractions, choose values for the letters which will not make any denominator zero.

14. Check the graph of a straight line by locating a third point.

15. Check the solutions of simultaneous equations by graphic methods.

VI. How to Use Short Cuts Effectively

1. Use short cuts only after the principles and meth

ods of the ordinary solution are grasped and completely understood.

2. Understand the theory of the short cut used.

3. Look ahead to see the general plan; watch for shorter methods.

4. Learn the short cut so that it requires no thought to use it.

5. Do not forget that ability to use the standard method plus the ability to use short cuts is better than the standard method alone.

6. Increase your ability to use short cuts by solving old problems by new methods.

7. Practice short cuts whenever you have a chance so to become familiar with their use.

8. Do not use short cuts merely as an "easy way out" of doing some work.

9. Do not spend time learning short cuts which you are very unlikely to use.

10. Do not expand a long product if any of the factors are zero.

11. Make use of any trigonometric relations to shorten work.

12. Learn the standard form of the equation of a straight line and a circle as a short cut in graphing.

13. Use cancellation as a short cut.

VII. How to Profit from Class Work

1. Come to class with an attitude which is favorable to learning.

2. Be prepared to contribute to the class work.

3. Do not sit back and let a few students do all the work.

4. Take part mentally in every recitation or discussion which occurs.

5. Ask intelligent questions when something is done which you do not understand; ask to have problems put on the board and explained.

6. Profit by the criticism of the mistakes of other pupils.

7. Be on the alert to get new methods of work from the class discussions. Take note of any short cuts introduced.

8. Make a specific list of difficulties, problems, or material with which you want help in class.

9. Volunteer to answer questions and to demonstrate problems.

10. Make a chart showing your progress in class, including recitations, tests, and board work.

11. Rehearse the class work to yourself at home.

12. Study as soon as possible after class so to benefit by the group work.

13. Do not put your ideas "upon a shelf" as soon as the closing bell of class rings.

VIII. How to Make Daily Preparation for Algebra as Effective as Possible

1. Keep a list of the assignments. Annotate them to fit yourself.

2. Have the assignment in mind while studying.

3. Locate the exact step where your difficulty lies.

4. Go over returned daily papers. Learn from your previous mistakes.

5. Study the examples done in the book and then work them yourself without the book.

6. Do each day's lesson each day.

7. Learn the meaning and uses of new terms as you meet them. Make up illustrative examples.

8. Explain the lesson to another person.

9. Work difficult problems several times.

10. Do your own work yourself.

11. Do not depend upon an answer book. Work about five problems at a time and then compare answers.

12. Make use of any suitable time or labor saving devices.

IX. How to Review and Take Algebra Tests

A. *How to review and prepare for algebra tests:*

1. Keep a "blacklist" of problems which were difficult for you.

2. Go over returned papers and previous tests.

3. Distribute your time; concentrate on that in which you are weakest.

4. Review several days before a test so there will be time to ask questions in class before the test is given.

5. Pay particular attention to the announcement of a test so to get hints as how best to review.

6. Form the habit of summarizing what you learn. Summarize each topic studied.

7. Review the summaries at the end of each chapter.

8. Review for different types of tests.

9. Work miscellaneous problems rather than problems grouped according to types.

10. Study your strong points so to improve your weak ones.

11. Review by making out a test which you think representative of the work covered.

12. Review whenever you feel the need for a review. Do not wait until time for a test.

13. Occasionally review by studying with others.

14. Do not forget that the best preparation for any test is steady daily work all through the course and a thorough understanding of the subject matter.

B. *How to take algebra tests:*

1. Start with enthusiasm and confidence. Think of the test as a challenge of your ability.

2. Do not waste time. Get a good start. Settle down to work immediately.

3. Pay close attention to any and all instructions, either oral or written.

4. Read and copy the questions and problems carefully.

5. Take time to think about each problem first before starting on it. Plan your method of attack.

6. Find out what is given, what is to be found, and how it is to be found.

7. Do the problems in the order given if possible. Do the easiest ones first.

8. Do not jump to hasty conclusions. Avoid guess work.

9. Put in all the necessary steps. Be neat so you can easily check your work.

10. Be sure of your work as you proceed.

11. See if your answers seem reasonable. Check your work whenever time allows.

12. Make use of any short cuts with which you are very familiar and accurate.

13. Make every minute count. Keep active mentally. Do something.

THE INTERNATIONAL TYPE OF MAP*

By GEORGE M. BAKER,

Rand McNally and Company, Chicago.

An examination of the leading new elementary and high school textbooks in geography will reveal the fact that a new tendency is on foot in the direction of maps for the use of school children. The old political type of map, in which each state or country was in a different color, is apparently losing in popularity. In its place appears a dual type of map, combining both physical and political elements, a map whose divisions or regions are determined by contour lines, and whose color scheme indicates elevation and not political boundaries. It is at once apparent that such a dual map is richer in content than the old political map in that it gives the basic underlying physical data upon which use any intelligent understanding of the geographical facts of a state or country depends.

We are concerned at this point to know the origin of this new emphasis in the choice of maps for school textbooks. This school map is a simplified modification of the much more elaborate governmental map known as the International Map of the World, or more commonly spoken of as the One-to-One-Million Map. This map originated with Dr. Albrecht Penck of Berlin, and was first presented in 1891 before the Fifth International Geographical Congress, which met in Berne, Switzerland. The argument in support of such a movement as Dr. Penck proposed was brought about by the lack of any agreement in the matter of mapping the countries of Europe, which resulted in the greatest confusion, as each country used its own system of symbols. It was not until 1909 that an agreement for the specifications of the pro-

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*Read before the Geography Section of the Central Association of Science and Mathematics Teachers, Chicago, November, 1931.

posed International Map of the World was finally reached at the London Conference.

The salient characteristics of the International Map of the World are as follows:

(1) The scale of the map is 1:1,000,000. This means that a linear unit on this map represents a linear unit one million times as great on the surface as the earth. Or in concrete terms, 16 statute miles on the earth is represented by one inch on the map. The map of the United States on this scale would measure fifteen feet wide by nine feet high.

(2) Physical relief is to be indicated by contour lines and colors, both of which are internationally agreed upon. The color scheme is made up of shades of green for lowlands, followed by a succession of yellows, tans and browns, ending in a deep reddish brown for the greatest elevation. On the ocean, shades of blue indicate depths.

(3) There are standardized symbols used for railroads, roads, wireless stations, landing fields for air ports, etc.

(4) The projection is a modified polyconic.

Most of the countries of the world can now speak in a common map language. The adoption of such a scheme of mapping has moved with commendable progress. All of Europe, a large part of Africa, the Near East, nearly all of India, Siam and French Indo-China, a part of Japan, nearly all of South America, and many scattering sheets elsewhere, have been mapped. The United States of America makes a bad showing in this comparison. We have brought out only four of the fifty-two sheets required to cover continental United States. Eighty sheets would be required to cover the United States and its possessions. At this rate of progress it will require some seventy-five years to complete the undertaking.

Air navigation will probably speed up this work in the United States. Fliers obviously must use maps that show elevations. The Committee on Air Navigation Maps recommended in 1929 that sectional air maps be prepared on the International scale of 1:1,000,000.

Following the lead of the promoters of the International Map movement, with all its obvious advantages of uniformity, the leading teachers of geography as a

school subject are rapidly coming to use a more or less one-language type of map, whose main features conform to the International Map of the World. This means a dual type of map, which is basically a physical map, the regions of which are determined by contour lines, upon which is superimposed the necessary political data. There is a very commendable agreement as to the general color schemes used by these school geographers, adhering very closely to the color scheme internationally adopted. There is also a happy degree of uniformity as to which contour lines to use as dividing points. Most of these school textbook maps are found to make use of the following contour lines as division points: (1) sea level to 500 feet. (2) 500 to 1,000 feet. (3) 1,000 to 2,000 feet. (4) 2,000 to 5,000 feet. (5) 5,000 to 10,000 feet. (6) over 10,000 feet.

Probably the man who has done more than any other one individual toward popularizing this modified International Map in the American schools is Dr. J. Paul Goode of the University of Chicago. About fifteen years ago his series of physical maps appeared on the market, shortly to be followed by his 16 inch physical globe and his School Atlas, all in harmony with the International Map of the World as to make-up.

The time is near at hand when our school children will be using the same type of map right thru their school course, whether it be in their elementary and high school geography textbooks, or in the form of wall maps, or atlases, or globes—and perhaps air and automobile road maps. In other words, the school map of the future will be a modification of the International Map of the World, which will tremendously facilitate map reading on the part of the general public. In school and out in the fields of business and commerce, we will talk and read in a common map language.

HARVARD MUSEUM WILLED GREAT BUTTERFLY COLLECTION

The Harvard College Museum of Comparative Zoology is to receive a collection of butterflies and moths totaling some 75,000 specimens, through bequest from the late Andrew Gray Weeks. Many of the specimens are "types," that is, the originals from which published scientific descriptions were derived. Mr. Weeks also willed to the museum a fund for the care and increase of the collection.

THE BURBOT AS A SOURCE OF LIVE MATERIAL FOR PARASITE STUDY

By W. M. Tidd,

Ohio State University, Columbus, Ohio.

Teachers who have used living materials in their classes have no doubt noticed that they create an interest among the students which is not obtainable by the study of preserved or mounted specimens. Once a student's interest is aroused it becomes a personal satisfaction to find out things for himself. Natural appearances and the actuality of observing real, living animals are advantages of using live biological materials. This point is well illustrated in the study of parasitism. Furthermore, the collection of parasites for study from live or freshly killed animals permits students to observe their effects upon the host.

Attention was called to several sources of living parasite material in an article appearing in the January number of School Science and Mathematics for 1931.[1] I wish to call attention to the use of the burbot (Lota maculosa) as a source of living worm parasites. Several years ago while assisting in a food study of several species of commercial fish in the Sandusky fishing area of Lake Erie the author discovered that the burbot, one of the representatives of the codfish family, was heavily parasitized with a species of tapeworm identified as Abothrium crassum.[2] Of several hundreds of these fish examined not a single burbot over sixteen inches in length was found which did not carry adult worms of this species in the gastric caeca and intestine. In many cases larvae of the same worm were found enclosed in knot-like cysts over the wall of the stomach. This illustrates quite well the effects of parasitism upon the host.

In the general zoology course at Ohio State University, we use the burbot as one of the sources of living parasite material which provides our beginning students with a first hand knowledge of parasitism. This period is handled as a problematic situation. The students are provided with burbots in dissecting trays. By a median

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[1] An Unbalanced Aquarium for the Teaching of Biological Principles. By D. F Miller, School Science and Mathematics, Volume XXXI, No. 1, January, 1931.

[2] Identified by Ralph V. Bangham, Wooster College, unpublished material.

ventral incision they expose the viscera and examine them for parasites. Some of the encysted worms which are often found can be removed by puncturing the cyst with a sharp instrument. When the contents of the digestive tract are examined the discovery of many long tapeworms in the gastric caeca and intestine arouse considerable excitement in the class. It is not uncommon for some of the worms to stretch out to a length of sixteen inches before the scolex is removed from the cavity of the caecum. After removal the worms are transferred to normal saline solution and observed under a compound binocular or microscope.

The relationship of predator and prey is well illustrated while the students are examining the digestive tract for parasites. Burbots are voracious eaters and must possess enormous powers of digestion. It is not uncommon to find perch, pike perch, saugers, or minnows in the stomachs. This offers an excellent opportunity for a general discussion of the alternation of hosts through food, followed by the study of the life history of any one or more specific parasites. While fish apparently make up the greater part of the food of the burbot still occasionally one will find a stomach filled with Mayflies. When such forms are found they are removed and placed on demonstration where all the students can see them.

Commercially the burbot is of little value. Fishermen at the east end of Lake Erie often throw them back into the water when taken in their nets. Fish houses at Sandusky, Ohio, clean the burbots for their local trade. They are sold under the name of burbots, lings, or eel pouts. Because of their low commercial value freshly caught burbots can be easily obtained from the fish houses at Sandusky and other ports on Lake Erie at reasonable prices during the fishing season. When the fish are properly iced, examination has shown that the tapeworms will remain alive for four days after the fish have been caught, which seems to indicate that they can be shipped considerable distance inland.

FRATERNAL ORDERS IN ALGEBRA

(Nonsense as Preventive of More Nonsense)

BY THEODORE KAMBOUR,

Principal, High School, Montpelier, Vt.

Every teacher of intermediate or elementary algebra is often exasperated with the frequency with which pupils commit three different types of errors in fundamentals, which are the results of gross carelessness.

The first and outstanding exasperating and persisting error is the failure to recognize the necessity of the middle term in the square of a binomial. $(a + b)^2 = a^2 + b^2$ is a statement commonly found in examination papers. This error is not frequent when the class is dealing directly with squares of binomials under "Special Products." It begins to show itself when the class begins factoring i. e., after pupils have learned the product of the sum and difference of two numbers. This, no doubt, is a contributing factor to the later commission of these errors with the middle term of the square of a binomial. a^4+b^4 is declared to be the square of a^2+b^2.

This error is also often found in other parts of advanced work, especially in the cancellation process in fractions and in "Radicals," particularly in rationalizing such fractions as $\frac{\sqrt{a} + \sqrt{b}}{\sqrt{a} - \sqrt{b}}$ Pupils may correctly indicate that the proper process is to multiply the numerator and the denominator by the "conjugate" of the denominator. They will sometimes, alas and alack, do it thus:

$$\frac{\sqrt{a} + \sqrt{b}}{\sqrt{a} - \sqrt{b}} \frac{\sqrt{a} + \sqrt{b}}{\sqrt{a} + \sqrt{b}} = \frac{a + b}{a - b}$$

The omission of that $2\sqrt{ab}$ in the numerator is what has driven many an otherwise happy algebra teacher to pessimistic doldrums.

Not so common as this error is one just as irritating—that of "cancelling" common *terms* in numerator and denominator of fractions instead of cancelling common factors, thus by erroneously cancelling out b^2

$$\frac{a^2 + 2ab + b^2}{x + b^2} \quad \text{becomes} \quad \frac{a^2 + 2ab}{x}.$$

This error is less likely to happen when the class is dealing directly with reducing fractions to lowest terms than later, for instance in radicals:

$$\frac{\sqrt{6} - \sqrt{2}}{\sqrt{6} + \sqrt{2}} \quad \frac{\sqrt{6} - \sqrt{2}}{\sqrt{6} - \sqrt{2}} = \frac{6 - 2\sqrt{12} + 2}{6 - 2}$$

$$\frac{8 - 4\sqrt{3}}{4} = 2 - 4\sqrt{3},$$

when the 4 of the denominator is cancelled into the first term of the numerator.

A third common fundamental error is the failure to provide a denominator for the sum of fractions. Again pupils will usually commit few errors of this type while dealing directly with addition and subtraction of fractions. This difficulty arises more frequently after fractional equations have been studied and the pupils get the habit therein of multiplying both sides of the equation by the lowest common denominator, so causing the denominators of the various fractions to "disappear." No matter how carefully one anticipates this and guards against it, some pupils inevitably will sooner or later solemnly write that:

$$\frac{a}{b} + \frac{c}{d} = ad + bc$$

The fact that the majority of the better pupils respond to your careful teaching does not help your feelings much when some of the less accurate but well meaning youngsters, some so cherubic, commit these blunders in profusion; you are promptly reduced to profane ejaculation.

About a year ago I became nearly desperate because of my irritation over the results of an examination in which several illustrations of these fundamental errors were beautifully demonstrated, especially that of the erring 2 ab. I wondered what more I could do to drive that point home harder. I remembered a story told me years before of a minister who found his audience inattentive. He walked to the stairway leading from the platform to the floor of the auditorium and brought

startled gasps from his amazed congregation by sliding down the banisters. He didn't lack attention thereafter that day. Something dramatic and amusing! I had remembered that story a long time. I didn't doubt that his audience also remembered what he said after his slide even if they did better remember the slide. I had no banister in my classroom but I could do something unusual that would answer in creating startled attention to the middle term of the square of a binomial. Coming into the room after my class I carefully, reverently, and silently placed those corrected test papers on the desk where they could not fail to draw attention—you know how corrected test papers will do that little thing. Then, standing immediately between class and papers, without a word of preface, I solemnly delivered myself something like this, with appropriate gesture:

"My hair is getting white because of it; my temper is becoming frayed because of it. I would here stand on my head and wave my feet in the air or wear my necktie backward in this class if I could only convince you all that $(a + b)^2 = a^2 + \underline{\underline{2AB}} + b^2$."

Of course it was ridiculous, enough to make the class laugh with such abandon that I am afraid the principal would have inquired into it if I hadn't been safeguarded by being that myself. Well, we had further tests and, mirabile dictu, the 2 ab's were handled with respect more befitting their dignity and station in algebraic life.

That started me thinking about the possibility of doing something unusual, something the class would enjoy, that would deal with all three of the pernicious errors above described. I finally decided to try this idea of "Fraternal Orders" for pupils who commit any of these three types of mistakes. The Orders are the 2 AB fraternity, the Happy Cancellers, and the Non-Denominators. After our first examinations in fractions and fractional equations I announced the fraternal system and explained that Happy Cancellers was chosen for a name because members had been so eager and happy to find *any* excuse to cancel that they would do so in gross error. The name "Non-Denominator" is obvious enough.

I wanted further vivid and arresting qualities attached

to the scheme. I consequently procured a small box of chalk of varied and brilliant colors. At a remote part of the blackboard where records could be reserved as long as desired, I started a column which now reads about as follows:

Fraternal Orders	(Bright blue)
2 a b ///// ///// ///// ///	(Flaming red)
Happy Cancellers ///// ///// //	(Brilliant Yellow)
Non-Denominators ///// ///	(Livid Green)

Whenever a pupil in class or after-school group makes a remark that indicates he is making any of these mistakes, an additional mark is added to the proper space, indicating that another new member is initiated into the fraternity, or has been received into an order of higher degree within the fraternity. We do have second and third degree 2 AB's!

Is this initiation carried on in solemnity, quiet decorum, or so dignified that it hurts as a penalty? Never! The initiate is greeted with a whoop! And he, although chagrined, smilingly accepts the initiation as a sportsman should. When corrected tests are returned to the class, the new initiates are announced by name. As indicated in the chart, they are not *recorded* by name. There is no wish to keep a pupil ashamed or half-ashamed. They remember their personal errors but rest secure that the error is not paraded permanently by name before their class or others that use the room.

The results have been beneficial. Obviously I have no concrete statistics, but I do know that I am not so pestered as before by these elementary errors. Furthermore, the attitude of the class is better. It is also true that other classes hear of it so that the thing is now assuming traditional form. In time this should help focus

attention on these matters even before the intermediate group begins a year's work.

Occasionally remarks are overheard that indicate the attitude of the class toward this device. I have heard, in after-school groups, "Boy, you're wrong. 2 AB for you!" When a pupil in class makes a suggestion about an example that will lead me to say, "Ah! Greetings to our order. You are now a———," the class with gusto will roar, "Happy Canceller." And, cheer-leader-like, I help them make it snappy and enthusiastic.

Do pupils like to become members? I wondered if perhaps some pupil mightn't aspire to false glory. My fears were set at rest very shortly. We were trying to recall who had made an error qualifying him to the 2AB's. Someone suggested, "It was Jim." "It was not," Jim announced with glare, decision and vehemence. They don't mind legitimate initiation, but they do resent unjust inclusion on the list, and obviously they prefer not to get on the list.

My only fear now is that on some ill-fated day I myself will qualify for a membership! Of course I'd cheerfully set down another mark even though I'd boil within at my crass stupidity. On further thought it might help the cause. Perhaps I'd better make a mistake in class and see whether the youngsters can catch me.

I recommend that you try the idea—if you can safely have a bit of fun with your classes. Math classes often need a light motif. If you're for dignity at all costs, you won't use it, of course. Certainly you can use it if you're a teacher in the social or natural sciences or languages or any other subject, wandering thus far from your habitat into this mathematics environment. For instance, I can imagine an order for "Spellers" of simple words in English—*their, seize, too,* etc., or for pupils who fail to balance equations in chemistry. Of course you can't use it if you are a teacher with whom pupils make no repeated fundamental errors! If you doubt whether your classes would take to the idea, read this article to them. I'm going to read it to mine—if the editor accepts it!

THIRTY-FIRST ANNUAL MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

The Central Association of Science and Mathematics Teachers was in session in Chicago, Illinois, on Friday and Saturday, November 27th and 28th. The official headquarters were at the LaSalle Hotel, the meetings being held at the Austin High School on the first day and at the Adler Planetarium and Astronomical Museum and the Field Museum of Natural History on the second day. The Austin High School building is one of the newest and finest in Chicago, which fact, coupled with the fine hospitality and cooperation of the personnel of the school made it an ideal place for the sessions of the Association. Every possible provision was made for the entertainment and comfort of the exceptionally large attendance of members at the meeting. The session was presided over by Mr. Glen W. Warner, of Crane Junior College of Chicago, who has been president of the Association for the past year. The very fine cooperation which he has enjoyed from the various officers and members of the Association in carrying forward the work and the fact that the year has been a very successful one financially are tributes to his excellent administration.

THE FRIDAY MORNING PROGRAM

The Austin High School Concert Band, directed by Captain E. O. Schildhauer opened the program of the general session in the large auditorium at Austin High School Friday morning. Following the musical numbers, Principal Wilbur H. Wright, of Austin, delivered the Address of Welcome to the Association and the Response for the Association was made by Colonel Harry D. Abells, Superintendent of Morgan Park Military Academy, Chicago. After expressing the appreciation of the Association to Principal Wright and the Austin High School, Colonel Abells said in part:

As we gather in this high school at this Thanksgiving time, we are grateful for the inheritance and organization of the Central Association of Science and Mathematics Teachers which have come down to us and which have been made possible through the sacrifice and service of so many men and women. To a preeminent degree this Association has been imbued with the spirit of the injunction "Ye shall know the Truth and the Truth shall make you free." Because of this attitude the members have had a noteworthy independence of thinking, freedom from self aggrandizement and devotion to science and mathematics teaching and research. Furthermore, the influence of the Association has been a strong factor in keeping us science and mathematics teachers from the school master's deadening sin of getting into ruts. It has, so to speak, provided us with the necessary attics in our personalities to which we have retired and found a widening vision and renewed energy and faith. The Association, with its journal, School Science and Mathematics, has kept us abreast of the times and enabled our minds to retain their elasticity. As individuals, where we deem it advisable, we are able to adjust ourselves to new plans in education; to programs of pupil guidance; to unit methods; to individual differences, and other progressive movements. In fact for years our members have taken leadership in good teaching and pupil advancement. Moreover, it has been an inspiration to us teachers to come together in the sectional meetings and to realize that there are many of us with the same problems and aspirations. We have received encouragement and strength. Finally, this Association has brought about friend-

ships for many of us which we have cherished and which have enriched our lives.

President Warner then presented to the Association Professor H. E. Slaught of the Department of Mathematics of the University of Chicago, and who has been actively interested in the Association since the year of its organization. Dr. Slaught then delivered an address entitled "Number—The Language of Science." He pointed out the need for more and more training in mathematics in view of the fact that the trend is continually in the direction of using more and more mathematics in research in all branches of sciences and applied sciences. His presentation of the rise of the number concept among primitive peoples added greatly to the human interest of the lecture, which was already exceedingly interesting in every detail. The essential parts of Dr. Slaught's lecture are embodied in his article of the same title published on page 1092 of the December issue of this journal.

This lecture was followed by an illustrated lecture by Professor Carey Croneis, of the Department of Geology of the University of Chicago. He spoke on the subject "The Geologic Path of Life." His lecture embodied a most interesting and graphical account of the forms of life that arose during the different geologic ages and the relative amount of geologic time covered by each of these ages. He gave a most lucid account of the types of fossils and of their occurrence in the world.

The Friday Luncheon

Following Dr. Croneis's lecture the members went to the Austin High School dining room where excellent food prepared in their modern kitchen was served in cafeteria style while music was furnished by their "Little Theatre Orchestra."

The Section Meetings

The members met in their respective sections at one-thirty Friday afternoon. Reports of these meetings follow at the close of this article.

The Commercial Exhibits

From four until six o'clock Friday afternoon the members either met for a social hour in the Civic Room or made inspection of the commercial exhibits in the booths in the corridors. Great interest was manifest in these exhibits which were unusually numerous and attractive. There the members saw many new and interesting helps for teaching consisting of books, charts, and apparatus and supplies for laboratory and classroom. This time also permitted the members to make an inspection of that remarkable new building.

The Reception and Banquet

Following the Annual Reception from six to six-thirty in the Civic Room Friday afternoon, the Association went to the Austin High School dining room for the Annual Banquet. Austin is exceptionally well equipped to handle such a banquet as this because of the size and beauty of its dining room and decorations and because of the facilities which it has for preparing, handling, and preserving large quantities of food. and because of the efficient management of that department. The management is to be congratulated for the excellent service provided. Speeches were made by President Warner, who acted as toastmaster, and several other members including Dr. Slaught, Mr. Roecker, Assistant Superintendent Tower, of Chicago and Dr. Henry B. Ward of Illinois University.

An interesting feature of the banquet program was the presentation to the members of eleven charter members of the Association who were present. Each of these spoke briefly. They were: Woralo Whitney, Hyde Park High School, Chicago, Departmental Editor

for Botany of this journal; Willis E. Tower, Assistant Superintendent Chicago Public Schools; Charles M. Turton, Bowen High School, Chicago, Ill.; Warren C. Hawthorne, Dean Pre-Medic School, Crane Junior College, Chicago; James H. Smith, Assistant Principal, Austin High School, Chicago; A. W. Augur, Tilden Technical High School, Chicago; Elmer E. Burns, Austin High School, Chicago; Clarence E. Comstock, Bradley Polytechnic Institute, Peoria; Charles W. D. Parsons, Central Scientific Company, Chicago; Albert L. Smith, Englewood High School, Chicago; Mabel Sykes, Bowen High School, Chicago.

The members were at this time delighted to hear the following resolution which had passed unanimously at the meeting of the officers and Board of Directors of the Association on Thursday night at the LaSalle Hotel, read by Dr. Edwin W. Schreiber, of the Illinois State Teachers College at Macomb, Ill.:

"Whereas Herbert Ellsworth Slaught, Professor of Mathematics, University of Chicago, has shown a deep and continued interest in the Central Association for more than a quarter of a century, appearing on our programs from time to time, Vice-Chairman and Chairman of the Mathematics Section, 1906-1907, publishing articles in our official journal SCHOOL SCIENCE AND MATHEMATICS, and whereas he is revered as one of America's leading educators in his chosen field, a text-book writer of national reputation and influence, a Past President of the Mathematical Association of America, be it therefore

"Resolved that the Officers and Board of Directors of the Central Association of Science and Mathematics Teachers delights to honor Professor H. E. Slaught by electing him an Honorary Member of this Association."

This resolution was put to a vote at this general meeting of members and passed unanimously. So Dr. Slaught is now one of our honorary members.

THE FRIDAY EVENING PROGRAM

Following the banquet the Friday evening program in the large Austin auditorium opened with music by a mixed chorus of ninety voices from the Austin High School. This was followed immediately by a Lecture-Demonstration by Dr. William Braid White, Director of Acoustic Research, of the American Steel and Wire Company, of Chicago. His topic was "The World of Tone and The World of Noise." He illustrated his lecture with many experiments showing the physical basis of musical sound and noise. He utilized the projection oscillograph developed in the laboratories of the American Steel and Wire Company from the original apparatus worked out by Westinghouse engineers in collaboration with Dr. White. This remarkable instrument threw upon a screen, when the auditorium was darkened, moving lines of light which pictured musical sound and noises and permitted the audience to compare and analyze these visually while they were being heard. He discussed some of the scientific problems of music and of musical instruments. He also showed how the problem of noise in great cities is being studied scientifically and exhibited "photographs" of noises from Chicago streets. The whole lecture was a wonderful demonstration of how such a technical subject could be made popular with an audience not all of whom had had recent training in the physics of sound.

THE SATURDAY MORNING PROGRAM

Among the items of business that were transacted at the Saturday morning business meeting in the small auditorium which will be of general interest to the membership were the following:

Mr. Fred Schriever read the report of the Conservation Committee of which he is Chairman and by vote of the members present he

and his committee were asked to continue with the work through the coming year.

The report of the Necrology Committee was read by its Chairman, Mr. Harry O. Gillet, recognizing the great loss to the Association through the deaths of Mr. Clarence Holzman and Dr. G. W. Myers. Following the reading of this report the members stood in silence for a time in respect to the memory of these men.

The nominating committee composed of Mr. E. E. Burns, Chairman, H. Clyde Krenerick, Louis E. Welton, W. G. Gingery, and J. S. Georges presented the following names, all of whom were unanimously elected:

President: F. R. Bemisderfer, East Technical High School, Cleveland, Ohio.

Vice President: Dr. Charles A. Stone, University of Chicago High School.

Members of the Board of Directors for 3 yr. term: Miss Katharine Ulrich, Oak Park-River Forest Twp. High School, Oak Park, Ill.; W. G. Gingery, Washington High School, Indianapolis, Ind.; J. Russell McDonald, J. Sterling Morton High School, Cicero, Ill.; O. D. Frank, University of Chicago High School.

Member of the Board of Directors for the unexpired term of F. R. Bemisderfer: E. O. Bower, East Technical High School, Cleveland, Ohio.

At the afternoon business meeting in the Field Museum the Board of Directors elected the following officers:

Members of Executive Committee: Mr. Walter G. Gingery, Washington High School, Indianapolis, Ind.; Miss Katharine Ulrich, Oak Park-River Forest Twp. High School, Oak Park, Ill.

Treasurer: Mr. Ersie S. Martin, Arsenal Technical High School, Indianapolis, Indiana. To succeed himself.

Secretary: Mr. Ross B. Wynne, Crane Junior College, Chicago, Ill., who has acted as assistant secretary for the past year.

It was also determined at this meeting that the next Annual Meeting, next November, will be held in Cleveland, Ohio.

Following a brief speech of acceptance by Mr. Bemisderfer, the morning business meeting adjourned for the lecture.

The Saturday Morning Lecture

(Reported by Mr. W W. Gorsline, Crane Junior College.)

The Association met for the Saturday morning lecture in the main auditorium of the Adler Planetarium and Astronomical Museum. Here the members listened to a special demonstration-lecture by Dr. Phillip Fox, Director of the Planetarium, on the subject of "Wonders of Starland." Those present in the large audience of members had the treat of their lives in witnessing the feats of the marvelous instrument containing one hundred eighty lenses and projecting the various astronomical objects on the dome of the building. In four minutes we were able to see the sun rising in the east, coming to the meridian, setting in the west, and then all the stars and planets. When the sun was dimmed the planets Mercury and Venus could be very easily seen and when the apparent motion of the sun was speeded up so that a year passed in four minutes these planets revolved around the sun in their respective orbits.

The twelve journeys of the moon about the earth during the single revolution of the earth about the sun in one year were shown also. It was interesting to see all the phases of the moon from new to full and to old as it came toward the sun and away from it. Dr. Fox could flash on the dome at any time the various circles such as the meridian, equator, ecliptic, etc., graduated in degrees and hours, and show the relation of the sun and planets to these. A difficult study was made easy in a few minutes. By tilting the axis of the mighty instrument so that it pointed directly vertical, we

saw the sky as one at the north pole would see it. On March 21st the sun went around us on the horizon. Part of the great dipper was below the horizon. Dr. Fox also tilted the projector so the constellations at the south pole were visible. Due to the procession of the equinoxes the earth's axis describes a circle in the northern sky making the complete circuit in 25,000 years. Dr. Fox tilted the horizontal axis of the projector so we could see the sky as it looked 12,000 years ago. The Southern Cross, always invisible to us, was clearly seen in the sky. We also saw the sky's appearance 12,000 years in the future. After witnessing these spectacles we felt very much repaid for our hour spent at the Planetarium and we advise any one going to Chicago to be sure to visit this wonderful building.

Guide-Lecture Tours of Field Museum of Natural History

(Reported by Miss Katharine Ulrich, Vice-President of the Assn.)

Members of the Association assembled in the main hall of Field Museum at 11:00 a. m., Saturday, Nov. 28th, and were divided into three groups of about fifty each—with Association Leaders as follows:

Anthropology group—Miss Lillian Boudurant, Oak Park High School, leader.

Biology group—Mr. Jerome Isenbarger, Crane Junior College, leader.

Geology group—Miss Alice Hahn, Proviso Township High School, leader.

A guide—lecturer from Field Museum staff was assigned to conduct each group through the Museum.

While each group made a general tour of the Museum, only outstanding exhibits were emphasized. The Anthropologists saw Pre-Historic Hall and the reconstruction of a Neanderthal Family—and the most outstanding exhibits in American Indian Hall. The Biology guide emphasized the seasonal habitats of animals and the Hall of Plant Life with its wax and glass flowers, the plants grown from seeds taken from mummy cases and economic plants. The reconstructed Carboniferous Forest was probably the greatest surprise to the geology group. Fossil Hall with its mural paintings of reconstructions of geological periods, the vast mineral collection, model mines and the meteor collection were also emphasized.

Members of the Association expressed their satisfaction with these tours. Out of town members appreciated the opportunity of having guides explain the exhibits and of having the privilege of asking them questions. Many city and suburban teachers had not been through the Museum in recent years so they also appreciated the opportunity provided by a personally conducted tour.

The members of Central Association of Science and Mathematics Teachers are greatly indebted to Dr. H. S. Simms, Director of Field Museum, and to Miss Cornell, who has charge of all guides, for extending them this courtesy on Saturday—their very busiest day, when hundreds of children visit the Museum to study the exhibits. It was the consensus of opinion that these tours were one of the best and most practical parts of the annual program.

Sectional Meetings

Joint Meeting of The Biology, General Science, and Geography Sections

The Biology, General Science, and Geography Sections met in joint session in the Large Auditorium at Austin High School with Mr. Grant Cook, Chairman of the Biology Section, as acting chairman of the meeting. The principal part of the program was a lecture on "Conservation" by Professor Henry Baldwin Ward, Head of the Zoology Department at the University of Illinois. Dr. Ward

gave a very thorough discourse on the general subject of Conservation. He pointed out ways and means to advance conservation as a part of the Nation's progress. It was made apparent that although we should not relax our efforts to conserve plants and other forms of life that we should devote much more time and effort to the reestablishment of the native life of our country. Reforestation especially should be encouraged. He insisted that the breeding places of animals be increased and urged that every effort be made to reestablish the balanced condition among plants and animals in the wild state. He spoke of the increased portion of public parks which are being devoted to conserving animal life. He recommended that all waste land everywhere be so used. His address was applauded enthusiastically and was followed by such enthusiastic open discussion that the Chairman had difficulty in adjourning the meeting for the necessary business sessions which followed.

The Biology Section.

At the business meeting which followed Dr. Ward's lecture the Biology Section acting upon the recommendations of their nominating committee unanimously elected the following officers for next year:

Chairman: Dr. William Gould Vinal, Cleveland School of Education, Cleveland, Ohio.

Vice-Chairman: Mr. Joel W. Hadley, Shortridge High School, Indianapolis, Ind.

Secretary: Mr. Fred R. Platt, Harrison Technical High School, Chicago, Ill.

General Science Section

Mr. W. L. Beauchamp, Chairman, presided at the business meeting which followed Dr. Ward's lecture. The nominating committee which he appointed proposed the following officers for next year, all of whom were unanimously elected:

Chairman: Ira C. Davis, University High School, Madison, Wis.

Vice-Chairman: Paul G. Edwards, Supervisor of Science, Chicago, Ill.

Secretary: Nathan Neal, P. Henry Junior High School, Cleveland, Ohio.

Geography Section.

After a joint meeting with the Biology and General Science groups at which Professor Henry Baldwin Ward, of the University of Illinois, spoke convincingly on "Ways and Means to Advance Conservation as a Part of the Nations' Progress," the Geography section adjourned to the Geography class rooms of the Austin High School for a special program on cartography and cartographical materials.

Mr. Geo. M. Baker, Rand McNally and Co., discussing the International Type Map, gave a lucid and interesting presentation, showing the need for and importance of a type of map internationally recognized, using the same symbols, and agreeing on the same colors and contour lines, thus eliminating much confusion and allowing for the same interpretation in all countries alike. Although Europe has mapped practically its entire surface in accordance with these standards, the U. S. thus far has been extremely laggard. This is partly due, perhaps, to the *size* of the International Map, too large for practical use in the class-room, which difficulty has been largely obviated by the *modified* type of International Map, authorized by Dr. J. Paul Goode, of the University of Chicago.

Mrs. Viva Dutton Martin, Arsenal Technical High School, Indianapolis, Md., then captured the attention of the audience with an exceptionally fine demonstration of a project in relief modeling, exhibiting for inspection a model from Glacier National Park.

"Maps and Graphs as Tools in the Teaching of Geography," a

paper most ably presented by Miss Edna E. Eisen, Steuben Jr. High School, Milwaukee, Wisconsin, gave much of practical value, and served as a stimulus for better teaching and for a clearer understanding of the child in relation to his map work.

The nominating committee, previously appointed, and consisting of Miss Katherine Ulrich, Oak Park High School, Oak Park, Ill., Miss Christine Hahn, Milwaukee, Wis., and Miss Bessie Soyer, Austin High School, Chicago, then gave its report, and submitted the names of the following for office, all of whom were unanimously elected:

Chairman: Miss Villa B. Smith, Western Reserve University, Cleveland, Ohio.

Vice-Chairman: Miss Edna E. Eisen, Steuben Jr. High School, Milwaukee, Wis.

Secretary: Mrs. Viva Dutton Martin, Arsenal Technical High School, Indianapolis, Ind.

The meeting closed with a trip of inspection of the new Geography rooms and equipment of the Austin High School, guided by Mr. Thomas H. Finley, a trip not only enjoyable and instructive, but also conducive to new vision and resolution for finer geography class-rooms elsewhere.

ALICE J. HAHN, Sec'y.

Chemistry Section.

The meeting of the chemistry section was called to order by the Chairman, Mr. Harry T. Blair, Director of Science in the South Division High School, Milwaukee, Wis. The vice-chairman, Mr. Frank G. Anibal of Chicago, was present but the secretary, Miss Mary A. Doherty of Kenosha was not able to be present. In the absence of the regular secretary this report has been written by a secretary pro tem.

A program of unusual quality had been arranged through the hard work and earnest effort of the chairman. His effort was well rewarded by a fine turnout of seventy five for the annual sectional meeting which was held in the new Austin High School in Chicago. The program was very well balanced. An excellent lecture on a research topic, Chemistry of Oil Refining, by T. H. Rogers, Asst. Director of Research, Standard Oil Co., Whiting, Indiana. A very enthusiastic presentation of an educational topic, The Block Unit Scheme, by Clyde W. Holt, head of Chemistry Dept., East Technical High School, Cleveland, Ohio. A masterful presentation of another phase of education, Comparative Education, by our very genial friend and eminent schoolmaster, Professor N. Henry Black of the Jefferson Physical Laboratory, Harvard University, Cambridge, Mass., on the topic, "Impressions of Chemistry Teaching Abroad."

With the approval of the chairman an innovation was introduced into our regular procedure which it is hoped will be followed as a precedent by all of our science and mathematics sectional nominating committees. All past chairmen of the chemistry section, who were present at this meeting were invited by the chairman of the nomination committee to sit with the committee in making the following excellent selection of officers for next year's meeting which will be held in Cleveland, Ohio.

Chairman, Frank G. Anibal, University High School, Chicago, Ill.

Vice-Chairman, Clyde W. Holt, East Technical High School, Cleveland, Ohio.

Secretary, R. E. Davis, Lane Technical High School, Chicago, Ill.

A. F. MCLEOD, Acting Sec'y.

Mathematics Section.

The Mathematics Section of the Central Association of Science

and Mathematics Teachers met Friday afternoon, Nov. 27, 1931. In the absence of the chairman, Mr. J. T. Johnson, Chicago, and of the Vice Chairman, Mr. A. B. McCain, Milwaukee, the meeting was called to order by the Secretary, Miss Mary A. Potter, Racine, Wisconsin. Miss Potter appointed as Secretary pro tem, Mrs. Elizabeth S. Kanies, Chicago, and as nominating committee, Mrs. Elsie P. Johnson, Oak Park, Illinois, chairman; Mr. Charles Leckrone, Lake View High School, Chicago; and Mr. W. W. Gorsline, Crane Junior College, Chicago.

The first speaker on the program was Dr. Charles A. Stone of the University High School, Chicago. He gave "Reports on Experiments on the One Year Course in Plane and Solid Geometry." After giving a brief history of the investigation in this matter, Dr. Stone quoted from Professor Dunham Jackson's report (Minnesota), Mr. Seymour's report (New York City), and Mr. Austin's report (Oak Park). He concluded his paper with a recommendation that the Mathematics Section of the Central Association adopt a resolution as follows: "That this group stand opposed to the fusion of plane and solid geometry into a one year course." Mr. Maurice L. Hartung, University High School, Madison, Wisconsin, and Major C. H. Crandall, Culver Military Academy, who were the other members of Dr. Stone's committee also gave brief statements supporting Dr. Stone's point of view. A motion was then made, seconded, and carried, that the section adopt the resolution offered by Dr. Stone. Professor W. W. Hart of Madison said that the passage of this resolution was not sufficient and made the motion that a copy of the resolution and report of the action of the section be sent to the College Entrance Board and to the Mathematical Association of America. This motion was carried.

Mr. W. H. Carnahan, Shortridge High School, Indianapolis, Indiana, presented a paper on compass constructions. After reviewing the history of construction in which the straight edge and compass were the accepted tools, he showed the difficulty of drawing a straight line. This objection has been overcome by certain European writers who advance a system of construction in which the compass is the only tool used. The members of the section carried away with them mimeographed copies of three problems in compass geometry.

Dr. W. Granville, author of trigonometry and calculus textbooks, and former college president, now Director of Publications of Washington Fidelity National Insurance Company, Chicago, held the audience spell-bound as he explained the possibilities in a four dimensional world. He began his discussion with one dimensional space in which a point is the unit. Then two dimensional space in which the line is the unit. Then three, and four, and higher dimensional spaces. He explained carefully the generation of tesseract which is the unit of fourth dimensional space and showed clearly the difference between things as they actually are and as they would appear in fourth dimensional space. He left us rather feeling that as far as our experiences are concerned, we might be living in a fourth dimensional world in which time is the fourth dimension.

Dr. H. E. Slaught, University of Chicago paid tribute to Professor W. Myers of Chicago, who passed away suddenly a week before this meeting and Mr. Edwin W. Schreiber, Western State Teachers College, Macomb, Illinois, presented a paper, "A Tribute to Florian Cajori."

Mrs. Johnson, Chairman of the Nominating Committee made her report, and the following people were elected to office:

Chairman, Mr. W. H. Carnahan, Shortridge High School, Indianapolis, Indiana.

Vice-Chairman, Dr. Maurice L. Hartung, University High School, Madison, Wis.

Secretary, Miss Estelle Nash, Evanston Township High School, Evanston, Illinois.

Meeting adjourned 4:30 p. m.

ELIZABETH S. JANIES, Secretary, pro tem.

Physics Section.

The Physics Section met in Austin High School Friday afternoon, Nov. 27th, presided over by Mr. H. G. Burns, of Marshall High School, Chicago, Illinois. The program as arranged and published in the Year Book was carried out with some additional features. Mr. A. M. Clem of the J. Sterling Morton High School, Cicero, Ill., spoke on "Pupil's Errors in Physics as a Basis for Modifying Techniques of Teaching." Mr. C. E. Harris, of Austin High School, Chicago, spoke on "The Teaching of A. C. Currents in High School Physics." Mr. Clifford Holley, University of Chicago High School, spoke on "The Overview of the Unit in Physics." Mr. Wm. N. Parker, Engineer, of the Western Television Corporation, of Chicago, spoke on "The Broad Scope of Television." He gave a most interesting demonstration of television reception. Each of these addresses occasioned considerable questioning and discussion.

Mr. C. H. Walter, of Kenosha, Wis., Vice-Chairman of the section, presented an exercise entitled "A Demonstration of Laboratory Work by the Problem Method." Mr. Walter had arranged to have a number of pupils unknown to him and who had had no physics as a class for this demonstration. Certain questions were asked by Mr. Walter, such as, "Can all of you swim? How does your weight seem when you dive into water as compared with your weight on the shore? If a crowd of people get into a pool at the same time, what happens to the water line?" and similar questions. The pupils were told to adjourn to another room, a physics laboratory, where apparatus was to be found to verify certain conclusions in regard to a supposed piece of pure aluminum. After an hour of work they had finished a write-up of the exercise and were to have been called back for questioning about this experiment but lack of time prevented this.

Mr. D. L. Barr spoke on "Modulation in the Radio Receiving Circuit." He gave several interesting demonstrations.

A communication from Joseph Jannson, Vice President of the Association of Colleges and Secondary Schools of the Mid States and Maryland was read. It was pointed out that due to the rapid growth in the subject matter of physics and its application, it is no longer desirable to attempt a comprehensive treatment of all subdivisions of physics in a one year high school course. An attempt is being made by the Maryland Association to reorganize the physics course for more thorough teaching of the subjects attempted even though many equally desirable questions are omitted from the course. The letter was written with the purpose of instigating similar action and cooperation in the North Central Association. Upon motion the matter was left in the hands of a committee to be appointed.

The opinion was freely expressed that this had been an interesting and profitable meeting of the Physics Section.

The report of the Nominating Committee was made and the entire slate elected unanimously as follows:

Chairman, Mr. Chas. A. Marple, Central High School, Cleveland, Ohio.

Vice-Chairman, Mr. A. W. Augur, Tilden Technical High School, Chicago.

Secretary, Mr. D. L. Barr, High School, Mt. Pulaski, Ill.

F. M. CARL, Secretary.

Consolidated report respectfully submitted,
ROSS B. WYNNE, Assistant Secretary of the Association.

REPORT OF THE CONSERVATION COMMITTEE.

Members of the Committee: P. K. Houdek, Robinson, Illinois; O. D. Frank, School of Education, University of Chicago, Chicago, Ill.; J. L. Cooprider, Central High School, Evansville, Ind.; R. B. Simon, Western Reserve Academy, Hudson, Ohio; Fred Schriever, Chairman, Boys' Technical High School, Milwaukee, Wis.

This committee was appointed in response to a resolution passed by the Association November 29, 1930.

I. Findings of the Committee:

1. The Committee finds that there is a healthy, growing, and widespread interest in conservation.

2. Besides Federal and State agencies, various groups are found to be at work in the field of conservation, in schools, at sectional meetings of teachers' associations, and elsewhere. Notably conspicuous in this endeavor are such organizations as Women's Clubs, American Legion, The Kiwanis, Boy Scouts, and foremost the Izaak Walton League of America. The Committee has corresponded with various groups in Wisconsin, Illinois, and Ohio, urging that conservation speakers be obtained at various meetings. Some gain has been made in this direction but plans must be laid far in advance for best results. Response has been good where proper and timely effort has been put forth.

3. The various voluntary conservation groups are frequently found to be not working together as intelligently and effectively as might be desired. Conservation work needs better organization so that efforts do not overlap.

II. Conclusions:

A questionnaire was sent out to about 30 instructors in high schools and universities of Illinois, Wisconsin, Ohio, Indiana, and New York. From the answers to the questionnaire the Committee concludes:

1. That the Conservation of Natural Resources need not be taught as a separate study in the curriculum. The course of study is over-crowded as it is, and much time may be lost in a needless endeavor to gain the separate type of treatment as a distinct subject.

2. It would seem best to present conservation in correlation with other subjects now in the course of study, foremost among which should be: Biology and General Science, and the Social Sciences; certain phases of English, Economics, Chemistry and Physics also afford excellent opportunities for presenting the essential truths and ideals of conservation.

The Committee, then, recommends the presentation of the subject matter of Civics, Geography, History, Literature and the Natural Sciences from the point of view of conservation. Especially should the subject of conservation as applied to forests and forest resources be presented as a vital and integral part of the program of education.

III. Recommendations for Immediate Action:

1. That a conservation committee, (or committees) continue the study of this subject for another year.

2. The members of this committee urge that the sectional meetings of their respective state teachers' associations secure conservation speakers wherever possible. Chairmen of sectional meetings are usually glad to receive suggestions for improvement of programs whenever the suggestions are made early enough in the year to receive proper consideration and admit of appropriate action.

3. That the presentation of the subject matter of biology and general science be made from the viewpoint of conservation wherever possible.

4. That all schools which are in a position to do it should provide Out-Door Laboratory work. Seasonal activity should be provided: Tree planting, winter feeding and study of birds, bird house building, and the study of insects and weeds are a never failing source of interest and inspiration in any subject of study where they may be given an appropriate setting.

IV. Recommendations for Further Study:

1. A thesis may be written showing the facts in favor of conservation. This may be published in our Journal.
2. A conference and reading list on conservation may be compiled for students and teachers. Perhaps several lists may be unified.
3. A manual for the teaching of conservation may be prepared to help teachers supplement present texts and courses.
4. The publishers of text books may be interested to give a conservation slant to some of the material to be published in forthcoming text books.
5. Special college courses should be offered to train teachers in presentation of the subject of Conservation of Natural Resources.
6. The secondary school course now under preparation should contain provision for inclusion of the subject of conservation either through correlations or as a separate study.
7. In the state certification of teachers, special requirements in conservation education may be imposed upon applicants before permanent certification is granted.
8. Various clubs and sectional meetings should be urged to have conservation speakers.
9. All groups should avail themselves more of the aid of the Federal and State conservation agencies, and of national organizations dedicated to the cause of conservation.
10. Further suggestions should be sought for from leaders in conservation thought elsewhere in the country.

REPORT OF COMMITTEE ON NECROLOGY.

Your Committee on Necrology reports with sorrow the loss by death of two members: Professor George William Myers and Principal Clarence Lee Holtzman. Both have served the Association faithfully and effectively for many years. They have contributed generously of their time, energy, and intelligence. The Association holds them in grateful memory.

Clarence Lee Holtzman died August 2, 1931, at the age of sixty. For twenty-seven years he served the Waller High School, Chicago, first as teacher and then as teacher and assistant-principal. In 1930 he was made principal of the Motley Elementary School, Chicago. He joined the Association in 1904. He was active in the biology section; his name appeared frequently in its programs. He was elected chairman of the section in 1919. In 1924 the Association showed its appreciation of his abilities by making him its president. We revere his memory.

George W. Myers died November 23, 1931, at the age of sixty-seven. He was graduated from the University of Illinois in 1888; received the degree of Master of Laws from the University of Illinois in 1891, and the degree of Doctor of Philosophy from the Ludwig Maximilians Universität zu München in 1896. In 1888 he became a member of the faculty of the University of Illinois, where he continued until 1900, when Colonel Parker called him to the Chicago Institute. In 1901 he was appointed Professor of the Teaching of Mathematics and Astronomy at the University of Chicago, and in 1929 he was made Professor Emeritus. From the founding of the Central Association of Science and Mathematics Teachers, he has been actively interested in its work. He was an early member. His name has appeared frequently in the programs of the mathematics

section. For many years he has been a departmental editor of SCHOOL SCIENCE AND MATHEMATICS, first in mathematics and astronomy and later, until his death, in astronomy. His influence will continue to be felt through his text books, his other writings, and especially his many devoted students.

MRS. VIVA DUTTON MARTIN,
A. H. GOULD,
HARRY O. GILLET, Chairman.

REPORT OF RESOLUTIONS COMMITTEE.

Resolutions Committee offer the following Resolutions to the Association:

1. Resolved, that the Central Association of Science and Mathematics Teachers extend our thanks and appreciation, for the hospitality extended to us by the City of Chicago, Board of Education of Chicago, and especially to Principal, Wilbur H. Wright, of the Austin High School, Assistant Principal Jas. H. Smith, whose labors have made the 31st convention an outstanding meeting. To the faculty of Austin High School and all others do we extend our appreciation.

2. Resolved to extend our appreciation for the fine service rendered by the Austin High School Concert Band for their part on the opening program of the general session, to the Little Theatre Orchestra for the program during the noon luncheon, to the String Trio of Austin High School Orchestra for the program during the annual dinner, and the mixed chorus of 90 voices for the excellent numbers rendered during the evening.

3. Resolved, that we extend our appreciation to the R. O. T. C. unit of the Austin High School for the service rendered the Association by the many courtesies extended to its members, checking, furnishing guides, and offering information and help.

4. Resolved, that we extend our appreciation to the Austin High School Cafeteria and to the manager, Miss Esther Philley, for the prompt and efficient service rendered the Association at the noon luncheon and the Annual Dinner.

5. Resolved, that we extend our appreciation to the officers of the Association and especially to President Glen W. Warner and his associates for the excellent program presented to the 31st Annual Convention.

Respectfully submitted,
HELEN A. SOUTHGATE,
CLARENCE D. MCLOUTH,
M. J. W. PHILLIPS, Chairman.

ANIMALS DIE WHEN DEPRIVED OF RARE GASES IN AIR

Oxygen and nitrogen, chief constituents of the air, are not alone sufficient to keep life aglow, Prof. J. Willard Hershey of McPherson College, Kansas, reported to the American Association for the Advancement of Science. His experiments showed that animals die after living ten days to three weeks in air from which carbon dioxide and rare gases, helium, argon, krypton, etc. are removed.

Prof. Hershey predicted that helium atmosphere would be used in fighting diseases just as oxygen atmospheres are now utilized in treating pneumonia. Large factories and office buildings supplied with synthetic atmospheres in which oxygen is mixed with helium instead of nitrogen are also foreseen by Prof. Hershey as a result of his tests.—*By Science Service.*

EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred Nineteenth Meeting

SOMERVILLE HIGH SCHOOL

Room 307, Somerville, Mass.

SATURDAY, DEC. 12, 1931

PROGRAM

9:45 Meeting of the Executive Committee.
10:00 Business Meeting.
10:15 Reports of Committees.
11:00 Address of Welcome: Headmaster John A. Avery of the Somerville High School.
11:15 Address: "The Fine Structure of Spectrum Lines." Norton A. Kent, Ph.D., Professor of Physics at Boston University.
12:00 Address: "Analyzing the Universe." Cecilia H. Payne, Ph.D., Astronomer at the Harvard Observatory.
1:00 Luncheon. Price seventy-five cents.
2:00 Inspection of Somerville High School Laboratories.

OFFICERS FOR 1931-1932

President, Frederick M. Boyce, Phillips Andover Academy, Andover, Mass.

Vice-President, Lawrence A. Howard, High School, East Boston, Mass.

Secretary, William W. Obear, High School, Somerville, Mass.

Treasurer, William F. Rice, Jamaica Plain High School, Boston, Mass.

BUSINESS MEETING

The following were elected to Active membership:

John A. Dunn, High School, Charlestown, Mass. 138 Myrtle St., Rockland, Mass.

Raymond M. Knight, Wentworth Institute, Boston, Mass. 164 Calumet St., Roxbury, Mass.

William J. Nutter, Boston Trade School, Boston, Mass. 15 Hawes Avenue, Melrose Highlands, Mass.

Angelo Riccio, Central Junior High School, Quincy, Mass. 227 Boylston St., Watertown, Mass.

Preston Wood Smith, Rivers School, Dean Road, Brookline, Mass. Rose Cliff, North Weymouth, Mass.

Joseph C. Spang, High School, Peterboro, N. H. 301 Prospect St., Belmont, Mass.

The following were changed from Associate to Active membership:

John S. Barss, Phillips Academy, Andover, Mass.

Carl Johnson, North High School, Worcester, Mass. 73 Davidson Road, Worcester, Mass.

A communication was received from the Association of Science Teachers of the Middle States and Maryland asking for our cooperation in their attempt to secure a revision of the College Entrance Examination Board requirements in Physics. It reads in part as follows:

"The extraordinarily rapid growth in recent years of knowledge of those facts and principles constituting the subject matter of Physics, and the numberless applications of those facts and principles in modern, everyday life make it undesirable longer to attempt a comprehensive treatment of all subdivisions of Physics in a one year course in secondary schools.

"(1) To correct the overcrowding in subject matter which necessarily results from, and is perpetuated by, attempts to prepare pupils

for the present comprehensive examinations in Physics for college entrance,

"(2) To better realize the desirable outcomes of Physics teaching and to secure a reasonable degree of mastery of the topics studied,

"(3) And to enable each school to adapt its course in Physics to local conditions without weakening the college credit value of the course,

"(4) The Association of the Science Teachers of the Middle States and Maryland are endeavoring to secure the agreement of the secondary school and college teachers of Physics within the area that it represents upon selective groupings of subject matter in Physics, such as is suggested in Groups I to IV given later, each group of which is judged to constitute a desirable year's work in secondary school Physics, under the time allotment usually given to that subject.

"(5)

Group I	Group II
Mechanics (a)	Mechanics (a)
Electricity (a)	Electricity (b)
	Heat or Light
Group III	Group IV
Mechanics (b)	Mechanics (b)
Electricity (a)	Heat
Heat or Light	Light
	Sound

"Notes: Mechanics and Electricity (a) to constitute complete and more technical courses with problems and applications.

"Mechanics (b) to cover fundamentals only and to be less technical in character."

It was voted to refer this communication to our committee on College Entrance Requirements to be reported on at the next meeting.

REPORT OF COMMITTEE ON COLLEGE ENTRANCE REQUIREMENTS

By FREDERICK E. SEARS, *St. Paul's School, Concord, N. H.*

There seems to be agreement of the members of the committee that the paper set by the College Entrance Examination Board for June, 1931, was not too hard nor unduly easy. It appears perhaps at first to be a little easier than is necessary but the records of the candidates who took the paper, as reported by Mr. Cushing who was one of the readers in New York last June, show that the paper was an average one as far as difficulty is concerned. A number of teachers express the same opinion, that the paper was very fair.

In regard to individual questions Mr. Cushing reports that there was no criticism among the readers of any one question as has been the case in some other years. The readers did find that question 1-a, about the spring balance, and question 5-a, as to the meaning of "60 cycle" when applied to an electric current, were not well answered. In question 11-b, where the distances were given in fractions of a mile, some readers felt that it was in the nature of a "catch question." As it was on the optional part of the paper it seems a perfectly fair question.

As regards the distribution of the questions and their number it is perhaps doubtful whether the proportion is good when three questions are assigned to the subject of Mechanics in Part I and only one question respectively to each of the other four main divisions of the work studied. Speaking as one member of the committee I would like to see more questions and a greater choice.

The committee suggests, as a basis for discussion, some possible changes in the syllabus. A number of teachers think that the law for resistance in parallel should be omitted as it is seldom used in practice. The telegraph instruments and the arc light are becoming

obsolete. The study of combinations of cells in electricity might well be left out. To take the place of these the study of electron tubes might be required or a knowledge of the simple principles of radio could be added. One member suggests also the possibility of including a study of electric discharges in a vacuum and in various gases.

REPORT OF COMMITTEE ON NEW APPARATUS

By HOLLIS D. HATCH, *English High School, Boston, Mass.*

1. This apparatus is a Photoelectric cell with an amplifier. The circuit is as follows:

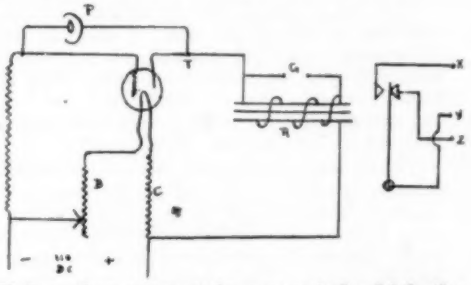
A=10 megohm leak

B=300 ohm 50 watt rheostat

C=420 ohm 50 watt resistor

R=8000 ohm relay

T=112A tube



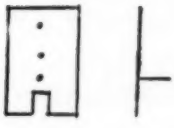
When light enters the cell P a tiny current is generated which the tube T amplifies. This tube current which varies from 2 to 10 milliamperes with the light or the adjustment of B may pass through a relay R or a galvanometer G. When a bell and cell are connected at x and y the bell rings every time the flashlight is turned on the photo cell. If y and z are in the bell circuit the bell rings continuously until light affects the cell and the relay opens the armature circuit. Obviously a motor, light, electric counter, etc., may be connected in either way to stop or start with the light.

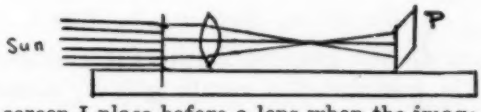
To test the characteristics of the photo cell a galvanometer is simpler to use. Its resistance is so much less than the relay which it shunts that the latter is unaffected.

When I hold colored glass in front of the photo cell blue makes no difference; the galvanometer reads the same as with clear glass. But red and orange glass cut the meter reading to zero. Some pieces of green glass pass enough actinic light to show an effect. If the direct light is shut off colored paper may be used to reflect light into the photo cell. White, violet and blue you see affect the cell and the amplifier current jumps up. Red and black give no response. Some glazed paper may reflect enough white light to give a result independent of color.

It is interesting to use an electric bulb with a rheostat in series to reduce the current. As the bulb's current and temperature decrease the photoelectric response disappears long before the brightness to the eye does because the emission loses the blue light first.

* * *





This piece of metal is a screen I place before a lens when the image

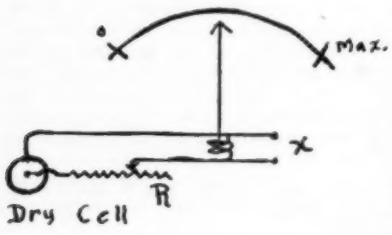
of the sun is caught on a screen in the experiment to determine focal length.

The student often sets fire to the paper or produces an image too bright to adjust exactly. With these three small holes before the lens two results are noticed: the intensity is reduced and the focal point is where all three spots are together. As the paper P screen is moved the three separate dots on it come together just as in the class room we teach that separate rays converge at the focus.

* * *

This board has three wires about 50cm long; two of No. 20 chromel and the third of No. 22. I connect them one at a time with this ohmmeter and find they have resistances of 1.5, 1.5, and 2.5 ohms respectively. In class we predict and then try the resistance of any two in series. For parallel I use the top two of 1.5 each first because the answer can be gotten mentally and then the 1.5 and 2.5 are tried last where arithmetic is necessary.

The above ohmmeter makes resistance teaching simple and was developed especially for class work. The commercial instruments start at hundreds of ohms and place the unknown resistance in series. Also their scale reads backward. This one measures to less than an ohm, places the unknown parallel to the movement and reads from left to right. The circuit:



The value of R is found by dividing 1.5 volts by the current for maximum deflection. The Weston instrument I use needs .04 amp; so R=37.5 of a 50 ohm rheostat. To use or calibrate adjust R for maximum reading and shunt known resistances across the movement. A resistance equal to that of the movement reduces the reading to one half: a short circuit makes it read zero and a very large resistance leaves the pointer at the right hand end. The practical range depends upon the movement's resistance and is roughly from one-third this resistance to three times it.

Mr. John A. Avery, Headmaster of the Somerville High School, was introduced by the Secretary. Mr. Avery very cordially welcomed the Association to the Somerville High School for the meeting. He called attention to the fact that Physics in the public high school is not primarily a college preparatory subject and that it, therefore, should not be too technical or scientific. The pupil should be taught the wonderful workings of nature rather than the dry mechanical treatment of so many text books. The chief contributions to the world of Thomas Edison, the great exponent of Physics, were light, facility in exchanging thought, and music. Can we do better than to make people see and hear more clearly and to bring harmony and appreciation to their inner beings?

THE FINE STRUCTURE OF THE BALMER SERIES LINES OF HYDROGEN

By PROF. NORTON A. KENT, *Boston University.*

In the general Rutherford-Bohr-Sommerfeld atom there is postulated a comparatively dense nucleus composed of protons and electrons about which nucleus revolve other

electrons. In the simplest atom—that of Hydrogen—the nucleus consists of but one proton; about it revolves one electron.

Bohr assumed (a) that there existed circular stationary orbits, in which, and only in which, this electron could revolve.

(b) that the angular momentum of the electron in its orbit always equalled $nh/2_{\pi}$ in which n might assume any integral value from unity up, h is Planck's constant, and $_{\pi}$ is 3.1416 and

(c) that, when the motion changed from any orbit of energy E_2 to any orbit of energy E_1 (E_2 being greater than E_1), $E_2—E_1=hv$, in which v is the frequency of the emitted spectrum line resulting from this transition.

These orbits possess radii which vary as the squares of the number n (see b, above). Sommerfeld developed the theory of elliptic orbits, the existence of which was indeed postulated by Bohr.

The scheme of possible orbits is such that the innermost group (n=1) possesses but one orbit, a circle; the second group (n=2) has two orbits, one circular and one elliptical; the third group (n=3), one circular and two elliptical orbits of different eccentricities; etc. The diameter of the circular orbit in any group equals the major axis of the ellipse or ellipses of the same group.

The introduction of an elliptic orbit changes the value of the energy because, as the electron has, in such an orbit, a variable speed, its mass must vary on the basis of the theory of relativity.

The transition of the electron from one orbit to another according to certain "selection" principles determines the nature of the spectrum.

Five known series of lines in the atomic spectrum of hydrogen exist (an infinite number are theoretically possible), the first three being formed by transitions of the electron from an orbit of higher energy to (a) the first orbit, giving the Lyman series, or (b) the second orbit, giving the Balmer series, or (c) the third orbit, giving the Paschen series. Recently the conception of a spinning electron has been added to the theory and the orbits or energy levels are thereby further altered.

For the lines in the Balmer series, called the H_{α}, H_{β}, H_{γ},

etc., five transitions are possible; hence the lines theoretically possess five components. For years they have been known to be doublets.

A search for further components appeared of considerable interest. The writer, assisted by Mr. Lucien B. Taylor and Miss Hazel Pearson, recently conducted a research dealing with this problem. The hydrogen spectrum, produced by a vacuum tube in liquid air, was photographed by two crossed Lummer plates. Microphotometer curves were made of suitable images in the patterns of H_α and H_β. A third component, though unresolved, was clearly indicated and the curves obtained were not inconsistent with the presence of two others, making five in all—a verification of the theory.

QUALIFICATIONS OF AMERICA'S 153,000 ONE-ROOM SCHOOL TEACHERS

How much training have the teachers of the 153,000 one-room rural schools of the United States is a question answered by a recent summary of the Federal Office of Education.

"If all the teachers of one-teacher schools stood side by side, their ranks would extend in an unbroken line 87 1/10 miles. Assuming this army of teachers were arranged in such a way that the one having received the least amount of training stood at one end and the one having received the largest amount of training at the other, a person reviewing this company would find it necessary to walk a distance of 8½ miles before coming to a teacher with a training equivalent to 2 years of high school.

"One would have to walk half the entire distance before approaching a teacher with training equal to high school graduation, and would have to continue his walk for a total distance of 67 3/5 miles before reaching the first teacher with the equivalent of 2 years of normal school education. The jaunt would be continued to within 13 miles of the end of the line before one who had the equivalent of a college education would be reached.

"What of the composite teacher of this group?

"Since men teachers are a great scarcity in one-teacher schools the typical teacher is a woman about 27 years old. She would have a total education of four years and one month above the grade school; her teaching experience would total 2 years and 6 months; she would receive an annual salary of $874; she would have under her care a total of 22 farm children, and she would be employed in her school for a total of 152 days a year.

"Although one-teacher schools are being abandoned at the rate of 4,200 per year in favor of consolidated schools, one-teacher schools still open their doors to more farm children than any other type of school."

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON,
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SPECIAL NOTICE.

Please observe that the Editorship of the problem department has changed. All communications relating to this department should go to the new Editor.

SOLUTIONS OF PROBLEMS.

Editor.—Persons sending in solutions should read carefully the instructions about the form of the solutions and the ink-drawn figures. Many times, a good solution is received, but poorly arranged and no India-ink figure given.

LATE SOLUTIONS.

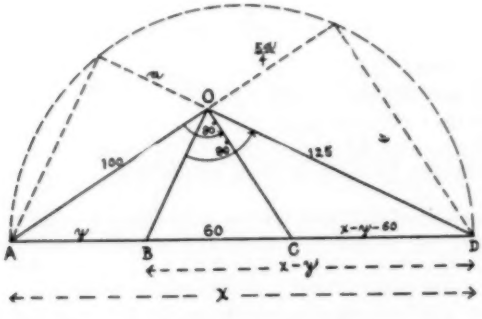
1187. *Lu Chin-shih, Soochow, China.*
1188. *Lu Chin-shih, Soochow, China.*
1191. *G. C. Lentini, the proposer, Boston, Mass., Lu Chin-shih, Soochow, China.*
1173. *Albert Whiteman.*

Late solutions for problems not previously worked are here presented.

1171. *Proposed by Louis R. Chase, Newport, R. I.*

Point O lies outside the straight line ABCD. AO = 100 ft., OD = 125 ft., and BC = 60 ft. $\angle AOC = \angle BOD = 90°$. Find the length of AD.

Solution by the proposer.



Describe a semicircle upon AD as diameter, and complete the figure as shown. The $\frac{5}{4}a$ is accounted for by the fact that the products of the segments of the chords are equal.

(1) $\dfrac{x-y}{125} = \dfrac{y}{a}$.

$$\frac{x-y-60}{\frac{5}{4}a} = \frac{y+60}{100}.$$

References: An angle inscribed in a semicircle is a right angle.
Two perpendiculars to the same line are parallel.
A parallel to one side of a triangle divides the other two sides proportionally.

From (1), $y = \dfrac{ax}{a+125} = \dfrac{80x-60a-4800}{a+80}$, whence

(2) $a^2x+60a^2+12300a-10000x+600000=0.$
(3) $x^2=(100)^2+(125)^2+250a.$

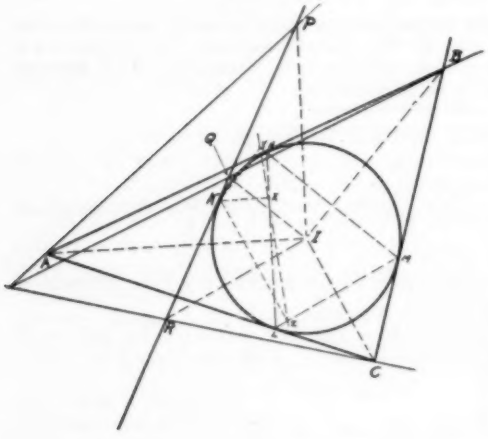
Reference: The square of the side opposite an obtuse angle of a triangle is equal to the sum of the squares of the other two sides, increased by twice the product of one of those sides by the projection of the other upon it.

Substituting in (2) the value $\frac{x^2-25625}{250}$ for a, as found from (3), and simplifying, we have
$x^5+60x^4-51{,}250x^3+31{,}640{,}625x-1{,}898{,}437{,}500=0$, the only positive root of which is found by Horner's Method to be 197.120146..... This represents in feet the length of AD.

1182. *Proposed by W. E. Baltzer, Battle Creek, Mich.*

I is the incenter of a triangle ABC. The tangent at any point K on the incircle is met by perpendiculars through I to IA, IB, IC at P, Q, R respectively. Prove that AP, BQ and CR are concurrent.

Solved by the proposer.

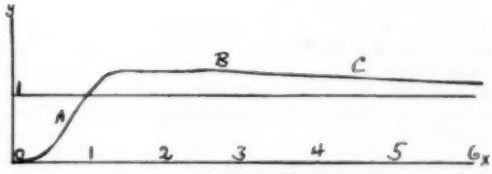


1. Through the points of tangency of △ ABC draw inscribed △ LMN.
2. Drop ⊥s to the sides of △ LMN from the point K and call the feet of these ⊥s X, Y and Z.
3. These three points are collinear since XYZ is a Simson line of the △ LMN. (There is a theorem due to Simson which says, "If from any point on the circumference of a circle lines are drawn perpendicular to the sides of an inscribed triangle, then the feet of these perpendiculars are collinear.")
4. LM is parallel to RI (Both ⊥IC).
5. ∴ KZ ⊥ RI (Since it was drawn ⊥ LM).
6. Also LM ⊥ IC (Elementary geometry).
7. ∴KZ and LM are the polars of points R and C respectively. (The chord of contact of tangents to a circle from an external point is the polar of that point).
8. ∴ Point Z, the intersection of KZ and LM is the pole of line RC. (The polars of two points intersect at a point which is the pole of a line connecting the first two points).
9. Similarly X and Y are the poles of AP and BQ respectively.
10. Since by step 3, X, Y and Z are collinear, then AP, BQ and CR are concurrent. (If any number of points are collinear then their polars with respect to a given circle are concurrent).

1183. *Proposed by Norman Anning, University of Michigan.*

Examine the function $F(x)=x^{th}$ root of x for maxima, minima, and points of inflection. $(x>o)$. Sketch the graph of $F(x)$.

Solved by F. A. Butter, Jr., San Jose, Calif.



Since $y = x^{\frac{1}{x}}$, $y = 0$, when $x = 0$.

By methods found in Calculus, we find $y = 1$, when $x \longrightarrow \infty$. Thus we have $\log y = \frac{1}{x} \log x$ and $\lim_{x \longrightarrow \infty} \log y = \lim_{x \longrightarrow \infty} \frac{\log x}{x} = \lim_{x \longrightarrow \infty} \frac{1}{x} = 0$. Then since $\log y$ has 0 as its limit y has $e^0 = 1$ as its limit as $x \longrightarrow \infty$.

Hence $y = 1$ is an asymptote to the curve $y = x^{\frac{1}{x}}$.

To find the maxima, minima and points of inflection we begin with equation

(1) $y = x^{\frac{1}{x}}$ or $\log y = \frac{\log x}{x}$. By differentiation

(2) $\frac{1}{y} \frac{dy}{dx} = \frac{1 - \log x}{x^2}$. Hence

(3) $\frac{dy}{dx} = \frac{x^{\frac{1}{x}} (1 - \log x)}{x^2}$. For a maximum or a minimum, we must have $\frac{dy}{dx} = 0$.

We shall study the two conditions which make $\frac{dy}{dx} = 0$.

(a) $x^{\frac{1}{x}} = 0$. This has been seen to be true only when $x = 0$.

This, however, is excluded by the conditions of the problem which requires $x > 0$.

(b) $1 - \log x = 0$, when $x = e = 2.718\ldots$

To show that $y = x^{\frac{1}{x}}$ has a maximum at $x = e$, we find y'' or $\frac{d^2y}{dx^2}$.

$y'' = \frac{x^{\frac{1}{x}} \left[(1 - \log x)^2 - 2x(1 - \log x) - x \right]}{x^4}$. Substituting $x = e$,

$y'' = \frac{e^{\frac{1}{e}} (-e)}{e^4} = -\frac{e^{\frac{1}{e}}}{e^3} < 0$. $\therefore$ $x = e$ gives a *maximum*.

The conditions (a) and (b) are the only 2 conditions possible, so that all critical points are obtained from them. Therefore, $(e, e^{\frac{1}{e}})$ is the only critical point and it is a maximum. Calculating these coordinates, we get $e = 2.7183$; $\sqrt[e]{e} = 1.4447$.

The points of inflection are found by setting $y'' = 0$ and solving for x. Hence, again there are just 2 possibilities:—

(c) $x^{\frac{1}{x}} = 0$, whence $x = 0$ (case (a) above).

(d) $(1 - \log x)^2 - 2x(1 - \log x) - x = 0$. Solve this as a quadratic in $(1 - \log x)$ thus: $1 - \log x = x \pm \sqrt{x^2 + x}$.

Hence we have 2 equations to consider:

$$f(x) = x + \log_e x + \sqrt{x^2 + x} - 1 = 0 \quad (3)$$

$$\phi(x) = x + \log_e x - (\sqrt{x^2 + x} + 1) = 0 \quad (4)$$

1. Consider $f(x) = 0$. It is obvious from the graph that $0 < x < 1$. By successive approximations (since neither (3) nor (4) can be solved algebraically), we find $f(.5820) = +.00027$ and $f(.5819) = -.00012$.

$$0.5819 < x < 0.5820.$$

Point of inflection is $(0.5819, 0.5819^{\frac{1}{.5819}})$, or $(0.5819, 0.3944^-)$

2. Consider $\phi(x)=0$. We readily note that
$\phi(4)=-.08585<0<+.13221=\phi(5)$, whence $4<x<5$.

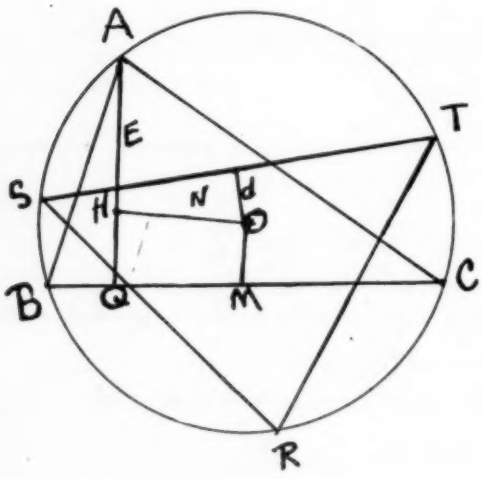
By successive approximations, we find that $(4.367)=-.00017$ and $(4.368)=+.00003$. Since the curve is nearly a straight line in (4,5) this is almost exactly true in so small an interval as (4.367, 4.368). Hence, it is safe to interpolate for 1 more decimal place, obtaining 4.3678. Therefore, the second point of inflection is

$$(4.3678,\ 4.3678^{\frac{1}{4.3678}}),\ \text{or}\ (4.3678,\ 1.4015).$$

1184. *Proposed by Nathan Altshiller-Court, University of Oklahoma.*

Construct a triangle given the magnitude of one angle and the positions of the orthocenter and center of the nine point circle.

Solved by Louis Sandler, New York City.



Let H and N be the orthocenter and center of the nine point circle respectively and $\angle R$, the given angle. Extend HN through N its own distance to O. With O as center and any convenient radius draw a circle. Inscribe the given angle SRT, and determine the distance, d, of O from ST. With H as center and $2d$ as a radius describe an arc cutting the circle at A. Draw AH. Draw OM parallel to AH extended and make $OM=d$. At M draw a perpendicular to AH (extended) determining B and C. ABC is the required triangle.

Proof:

ST = BC, since they are at equal distances, d, from O. Hence $\angle A=\angle R$ (Equal chords of a circle subtend equal arcs.)

Call E the mid point of AH. EHOM is a parallelogram. Hence N, being mid point of EM, is the center of the nine point circle of triangle ABC. Since NH = NO, H is the orthocenter of the triangle ABC.

The number of solutions is infinite since any circle may be drawn with O as center.

1185. *Proposed by Sudler Bamberger, Harrisburg, Pa.*

A rope one-half inch in diameter is coiled about a point in an even layer. Its end is four feet from the point. How much rope is in the coil?

Solved by Louis R. Chase, Newport, R. I.

With conditions considered ideal, the problem is to find the length of the line of contact of the rope with the supporting plane. This appears to be an Archimedean spiral whose polar equation is

$$r=\frac{\theta}{4\pi}.\qquad \text{Length, } s=\int\sqrt{r^2+\left(\frac{dr}{d\theta}\right)^2}\ d\theta.$$

$$\frac{dr}{d\theta}=\frac{1}{4\pi},\ d\theta=4\pi dr,\ \text{therefore } s=4\pi\int\sqrt{r^2+\frac{1}{16\pi^2}}\ dr.$$

$$s=\frac{4\pi}{2}\left[r\sqrt{r^2+\frac{1}{16\pi^2}}+\frac{1}{16\pi^2}\log_e\left(r+\sqrt{r^2+\frac{1}{16\pi^2}}\right)\right]_0^{48}$$

Using 7-place log tables, we have to 7 figures:

$s=14476.75$, inches; or 1206 ft., 4.75 in.

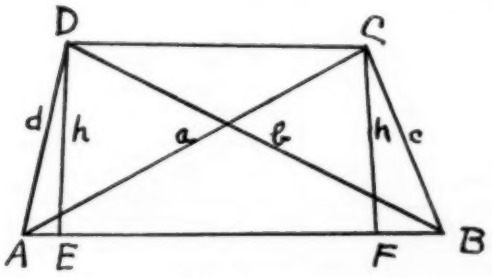
Now, to check against gross error, let us find the area of a circle with 48 inch radius, and multiply it by 2, since 2 inches of this rope cover an area of one square inch. This yields 14476.46 inches, which is in remarkable agreement with our more exact result above.

1186. *Proposed by George Sergent, Tampico, Mexico.*

Given the non-parallel sides and the diagonals of a trapezoid, show how to compute the area.

Solved by W. E. Buker, Leetsdale, Pa.

If the trapezoid is ABCD, let the given parts be:



$AC=a$; $BD=b$; $BC=c$; $AD=d$. If the unknown altitude is h, $AE=(d^2-h^2)^{1/2}$; $EB=(b^2-h^2)^{1/2}$ $AF=(a^2-h^2)^{1/2}$; $BF=(c^2-h^2)^{1/2}$. Since $AE+EB=AF+BF$, then $(d^2-h^2)^{1/2}+(b^2-h^2)^{1/2}=(a^2-h^2)^{1/2}+(c^2-h^2)^{1/2}$ (1)

If a, b, c, d, have numerical values, equation (1) can be freed of radicals, and Horner's Method used to determine the value of h. Then, since $AB=AE+EB$ and $DC=AF-AE$, we can determine the value of both AB and DC since we know h. We then apply the formula for the area of a trapezoid; *ie.*, $A=\frac{1}{2}h-h\,(AB+DC)$.

Also solved by L. R. Chase, Newport, R. I.

Mr. Chase suggests that when $a=51$, $b=74$, $c=40$, $d=25$. then $h=24$ and the area is 1380.—Editor.

1193. *Proposed by W. E. Buker, Leetsdale, Pa.*

Required to draw an n-gon with all possible diagonals. If a stroke is defined as a line made without lifting the pen or retracing any line, how many strokes are required?

Solved by A. Struyk, Paterson, N. J.

We give the following definitions: A *node* is a point to or from which lines are drawn. A *branch* is a line connecting two nodes. An *even node* is a node at which an even number of branches meet. An *odd node* is a node at which an odd number of branches meet.

We may now quote and use the following theorems, due to Euler: (1) A figure which has no odd nodes can be drawn in a single stroke; (2) a figure which has $2n$ odd nodes, and no more, can be completely drawn in n strokes, and no less.

These theorems make possible an easy solution of the proposed question. The nodes of our figure are the intersections of diagonals, and the vertices of the n-gon. An intersection of diagonals is an even node, because such a point divides each diagonal through it into two branches. Now, in an n-gon with all possible diagonals, a line is drawn from each vertex to every other, so that n-1 branches meet at each vertex. Hence, if n is odd every vertex is an even node, and if n is even every vertex is an odd node.

Therefore a single stroke is required to draw the figure if n is odd; and $\frac{1}{2}n$ strokes are required if n is even.

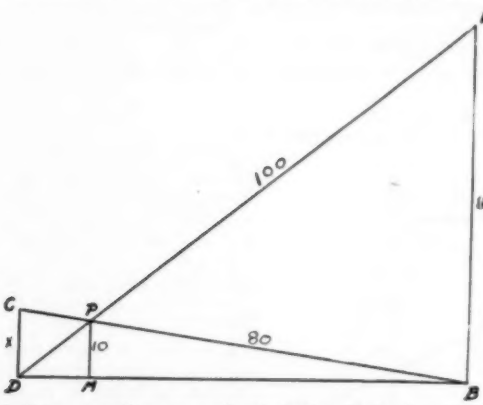
Also solved by Arthur J. Kavanah, Washington, Connecticut, and Henry W. Knerr, Atlanta, Georgia.

The reader may find reference to problems of this kind in Chapter IX of Ball's Mathematical Recreations and Essays.—Editor.

1194. *Proposed by Morris Savage, Paterson, N. J.*

AB and CD are both perpendicular to BD, with AD = 100, BC = 80. If they meet at P with PM = 10 and perpendicular to BD, find length of BD.

Solved by W. E. Batzler, Battle Creek, Mich.



1. By right triangles $CB^2 - CD^2 = DB^2 = AD^2 - AB^2$. Let CD = X, AB = Y; then $10{,}000 - Y^2 = 6400 - X^2$ or $Y^2 - X^2 = 3600$.

2. By similar triangles $\frac{1}{Y} + \frac{1}{X} = \frac{1}{10}$ or $X = \frac{10Y}{Y-10}$.

3. Substituting this value of X in (1) $Y^2 - \frac{100Y^2}{Y^2 - 20Y + 100} = 3600$ or $Y^4 - 20Y^3 - 3600\,Y^2 + 72{,}000Y - 360{,}000 = 0$.

4. Isolating the roots of this equation reveals that the desired root lies between 61 and 62.

5. Further methods of approximation give Y = 61.18 feet.

6. By substitution the corresponding value of X is, X = 11.95 ft.

7. Using either the value of X or Y DB = 79.10 feet.

Also solved by Arthur Kavanagh, Washington, Conn., Harry Prye, Tullahoma, Tenn., and A. J. Patterson, Wheeling, W. Va.

1195. *No solution received.*

1196. *Proposed by Guy C. Lentini, Boston, Mass.*

Given: If $mn = pq$
and $m + p = n + q$
Show that $m = q$, $n = p$

Solved by A. E. Kerstetter, Chicago, Ill.

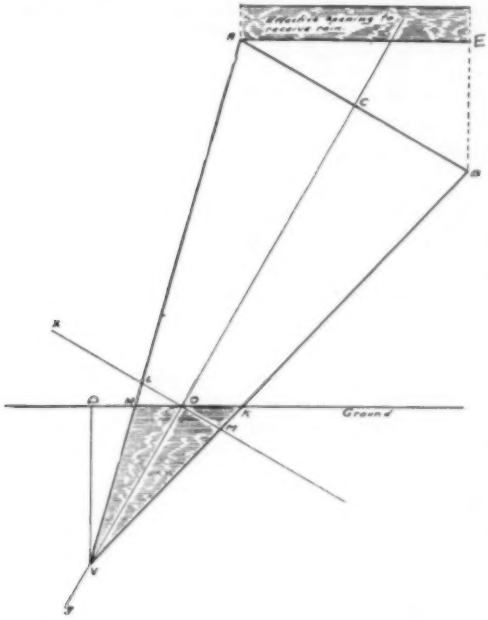
If $mn = pq$ ..... (1)
and $m + p = n + q$ ..... (2)
From (2) we have
$m - n = q - p$ ..... (3)
The square of (3) plus 4 times (1) yields
$m^2 + 2\ mn + n^2\ \ q^2 + 2qp + p^2$
or $m + n = +(q + p)$, or $-(q + p)$ ..... (4)
Solving (3) and (4) we get
$m = q,\ -p,$
and $n = p,\ -q$

Also solved by A. J. Patterson, Wheeling, W. Va., Martha Liddell, Bartlesville, Okla., W. E. Buker, Leetsdale, Pa., Fred Dellett, Ft. Hays, Kan., T. A. Bickerstaff, University of Mississippi, A. Struyk, Paterson, N. J., A. S. Merrill, Missoula, Mont., J. L. Stearn, George Washington University, Henry W. Knerr, Atlanta, Ga., W. E. Batzler, Battle Creek, Mich., Stewart W. Taylor, Gary, Ind., S. Maurice Cohn, Philadelphia, Pa., R. T. McGregor, Elk Grove, Calif., Margaret Jean Sinclair, Waukegan, Ill., and Clarence J. McGivens, New Orleans, La.

1197. *Proposed by Harry Frye, Tullahoma, Tenn.*

Just before a rainfall a right circular conical flower cup ten inches in height with a five inch mouth was stuck into the ground with the axis of the cone at an angle of sixty degrees to the level of the ground. The point of the cone reached into the ground to a vertical depth of three inches. After the rain the surface of the water in the cone was at ground level. How many inches of rain fell?

Solved by Lewis D. Rice, East Sparta, Ohio.



$AB = 5''$. $CV = 10''$.
$VD = 3''$. $\angle COK = 60°$.
Let $\angle BVC = \theta$
Then $\tan\ \theta = \frac{CB}{CV} = \frac{1}{4}$
and $\theta = 14°\ 2'\ 10''$.
$\angle DVH = 30° - \theta$
$HD = 3\ \tan\ (30° - \theta)$
$\angle DVK = (30° + \theta)$
$DK = 3\ \tan\ (30° + \theta)$
$HK = DK - DH = 3$ [tan $(30° + \theta)$ − tan $(30° - \theta)$]
$\angle DVO = 30°$

$$VO = \frac{3}{\cos 30°} = 2\sqrt{3}$$

$$OM = \frac{LM}{2} = VO \tan \theta = 2\sqrt{3} \times \tfrac{1}{4} = \frac{\sqrt{3}}{2}$$

The base of the cone HKV is an ellipse with semi axes $\frac{HK}{2}$ and $\frac{LM}{2}$ and its area is $\pi \times \frac{HK}{2} \times \frac{LM}{2}$ which reduces to $\frac{24\pi\sqrt{3}}{47}$.

The volume of the cone $= \frac{1}{3} \times 3 \times \frac{24\pi\sqrt{3}}{47} = \frac{24\pi\sqrt{3}}{47}$.

The area of the opening at top $= \pi \frac{AB}{2} \cdot \frac{AE}{2} = \frac{25\pi\sqrt{3}}{8}$, since $AE = 5 \cos 30° = \frac{5\sqrt{3}}{2}$.

$$\text{Rainfall} = \frac{\text{Volume}}{\text{area}} = \frac{192\pi\sqrt{3}}{47.25\pi\sqrt{3}} = \frac{192}{1175} = .1634 \text{ (inches)}.$$

Also solved by Stewart W. Taylor, Gary, Indiana, and *A. J. Kavanagh, Washington, Conn.* One incorrect solution was received.

1198. *Proposed by Peter Drohan, Toronto, Ont.*

One hundred feet of flat tape 1/10 of an inch thick is rolled into a coil. Find the diameter of the coil.

Solved by W. E. Buker, Box 66, Leetsdale, Pa.

Let x in. = diameter of the coil.
$(\pi x^2)\ /4$ sq. in. = area of coil.
$1/10 \times 100 \times 12 = 120$ = Area of edge of tape.
$(\pi x^2)\ /4 = 120$
$x = \sqrt{480/\pi} = 12.36$ = Diameter of the coil.

Also solved by Arthur J. Kavanagh, Washington, Conn.

FOR HIGH SCHOOL STUDENTS.

As suggested in the December issue, the Editor would like to enlist the interest of high school students in the easier problems proposed for solution. For those high schools whose classes in mathematics or mathematical clubs or students as individuals make noteworthy contribution to this department the Editor will give honorable mention. Teachers are urged to make report to the Editor of extensive study as suggested above.

PROBLEMS FOR SOLUTION.

1211. *Proposed by Stewart W. Taylor, Gary, Ind.*

"Given a circle of radius a, and a taut string of length b attached to the circumference. Find the area that may be swept out by the string in the plane of the circle. Take $b \leq \pi a$ to eliminate the discussion of double areas. The area required lies external to the circle."

1212. *Proposed by W. E. Batzler, Battle Creek, Mich.*

Find the equation of the locus of the center of a circle which is tangent to a given line segment and also tangent to the circle on that line segment as a diameter.

1213. *Proposed by A. J. Patterson, Wheeling, W. Va.*

Construct a plane triangle having given the base, the vertical angle, and the bisector of the vertical angle.

1214. *Proposed by R. T. McGregor, Elk Grove, Calif.*

Proposed: Find the sum to infinity of

$$1+\frac{2^3}{\lfloor 2}+\frac{3^3}{\lfloor 3}+\frac{4^3}{\lfloor 4}+\cdots.$$

1215. *Proposed by W. E. Buker, Leetsdale, Pa.*

Evaluate the $\lim_{x \to o} \frac{e^{-\frac{1}{x^2}}}{x^n}$.

1216. *Proposed by E de la Garza, Brownsville, Texas.*

Find four consecutive integers whose product is 24024.

SUMATRA'S WILD ELEPHANTS CANDIDATES FOR PROTECTION

Sumatra still has some wild elephants, and it is the only island in the great Dutch East Indian empire that can claim that distinction. Hence, an effort is being made to establish a preserve where they may be protected against the hunters who kill them for their ivory and the traders who capture them and lead them into domestic servitude.

In former centuries, particularly during the power of the Atjeh princes, elephants were very largely used as beasts of burden, but in the last decades they have been much exported. Because of the dangers and difficulties of sea transportation, a measure was passed in 1909 forbidding capturing or killing of certain wild animals, including particularly elephants.

Elephants often do great damage to plantations, but not enough to warrant wholesale killing. Moreover, herds of elephants approaching plantations can generally be detected, rounded up and scared away. Hunting by so-called sportsmen has been carried on, often recklessly.—*Science Service.*

BOOK REVIEWS

The Mathematical Part of Elementary Statistics, by Burton Howard Camp, Professor of Mathematics, Wesleyan University. xxi+407 Pages. 14.5x20.3 cm. D. C. Heath and Co., 285 Columbus Avenue, Boston. 1931. Price $3.60.

This book deals with the mathematical part of statistics. It is divided into two parts, the first of which may be taken without the second. The first part is more elementary than the second. It does not presuppose anything beyound analytic geometry. There are ten chapters in this part with headings as follows: Graphs and Notation, Moments, Cumulative frequency, Grouping Errors—Small Total Frequencies, The Normal Law, Applications, Time Series; Trend and Ratio Charts, Correlation,—the Surface and the Coefficient, Regression—Interpretation of r, Normal Surface—Correlation of Non-Measurable Characters.

Part II consists of seven chapters as follows: Probability, Approximations to the Point Binomial, Frequency Curves, Sampling, Correlation—Further Topics, Multiple Correlation, Finite Differences. This part does not presuppose a course in calculus but it does employ some of the symbols of calculus—especially the integral sign.

The book is well written and presents an attractive appearance.

J. M. Kinney.

The Philosophical Basis of Biology by J. S. Haldane. Pages xiii+155. Doubleday, Doran and Company, Inc., 1931. Garden City, New York.

This book is based upon the lectures given by Professor Haldane in 1930 under the Donellan Foundation at Trinity College, Dublin. Revision and extension of those lectures have been made, and there is a supplement which deals with certain important and recently published books. The wide tendency, nowadays, to develop and utilize a biological interpretation of human thought and behavior causes this book to be especially interesting. Then, the vitalistic ideas often associated with the author seem to have caused him to wish to place himself in a somewhat different position, as observed by general readers, biologists, and philosophers.

It would seem that no one could question whether a living plant or animal is different from the same plant or animal when dead. In fact we cannot even state the problem without implying that "living" and "dead" represent fundamental differences. Thus to state the problem, then to assert that no difference exists, seems absurd. The so-called vitalistic idea stood for whatever it is that makes the difference between "living" and "dead." But strangely enough Haldane now says: "Vitalism came, however, during the latter half of the last century, to be almost universally rejected by biologists, and for a very good reason. We can now show from both common observation and from experiment that whatever happens within the body of a living organism is ultimately dependent on conditions outside it, in its environment. We cannot separate organic from environmental structure, any more than we can separate the action of the environment from the reaction of the organism."

The author contends that the usual assertion that biology is a less exact science than physics or chemistry is incorrect when environment and organism are studied as a unit, not as separate things. "Biology is just as much an exact science as any other science. In so far as we discover co-ordinated maintenance we reach exactitude in biology." If however, we regard biology as explainable only on the basis of physics or chemistry, we make biology itself an inexact science. This is because we omit whatever it is that makes living things and environment interactive and interdependent. It is only by such an acceptance of the unity of the environmental or ecological

interpretation of biology that exactitude and sound conclusions may be secured. Living things are alive only when they and their environment are coordinated in such ways that life phenomena may result. Environment or organism, either studied wholly apart from the other, means that non-living material is being studied, hence cannot be an exact study of biology. We must accept life phenomena as part of biology and must recognize that we cannot adequately explain them upon the basis of physics and chemistry. From a biological point of view, physics and chemistry take on meaning only as they contribute to interpretation of living things. Therefore, neither mechanistic nor vitalistic ideas can be fully accepted, but these and the "biologic" must be welded into a new kind of interpretation. Haldane believes that present thought is heading in this direction.

We may illustrate this tendency by reference to occurrences within one field of biology. The subject became divided and specialized from botany and zoology into anatomy, morphology, neurology, cytology, physiology, and so on, including two score or more highly specialized refinements. Each of these was needed and each makes continuous and valuable additions to recorded knowledge. But somehow a piece of work when completed in any of these specialties, isn't really finished, just because of its separation from all the other considerations which are involved in a living organism. And by the same token the biological philosophy of any highly refined specialist is likely to be very faulty because of its omission of the whole living organism and of the environment to which the philosophy relates. Synthesis in interpretation of the meaning of the results of specialized study is just as necessary as is the continued productivity of specialized study. So compact and thoughtful a book as this cannot be adequately presented in a review. The best one can do is to present its point of view and a few of its pertinent lines of thought, and recommend the whole book to those who really want to know its content.

Otis W. Caldwell.

The First Course in Quantitative Analysis, Containing a Group of Lectures and Laboratory Experiments by Floyd Hamilton Fish, Professor of Analytical Chemistry, The Virginia Polytechnic Institute. Cloth. Pages x+120. 19x13 cm. 1931. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $1.25.

A new text, by Blakiston, of one hundred twenty pages is off the press and intended for use by students in both engineering and applied science, and agriculture.

The subject matter is presented in accordance with modern ideas in the teaching of Quantitative Analysis in that there is no division of the book into parts as gravimetric and volumetric. The author follows the method of telling the student in detail exactly what to do and why, rather than giving the theory involved in a determination and expecting him to supply his own method of procedure.

Great care is exercised in the wording of definitions and many problems are used to fix in the minds of students principles and definitions. In the solution of problems, the author takes great pains to steer his students away from the chemical factor habit and suggests in its place a unit content or product method which the beginner can readily understand.

Part II for agricultural students gives detailed methods for the determination of moisture, crude fibre, crude protein, and fat in feeds. In fertilizer analysis the determination of total nitrogen, available and total phosphorus are covered.

The work in quantitative analysis as presented in this text presupposes a thorough knowledge of Qualitative analysis. Electrolytic, potentiometric, calorimetric and other methods requiring expensive apparatus or elaborate set-ups are omitted as having no place in a course for beginners.

Thomas R. Ernest.

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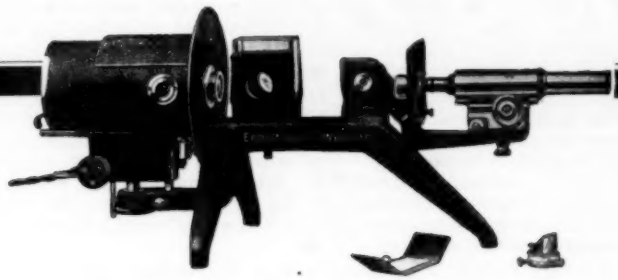

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Chemistry for Students of Agriculture and Home Economics, by Robin Charles Burrell, Ph.D., Assistant Professor of Agricultural Chemistry, Ohio State University. Pages xviii+459. 21x15x3 cm. First Edition, 1931. Cloth, $3.50. McGraw-Hill Book Company.

It is becoming more and more evident that the student who is not majoring in chemistry but wants to know the science as a person of culture, should not be burdened with too many of the technical and mathematical difficulties. For such students the author has written this work. He has divided the book in five parts.

Part I treats of the fundamental principles of general chemistry. Topics such as Atomic theory, Kinetic theory, ionization, Periodic tables, atomic structure are briefly discussed in one chapter. The next two chapters deal with facts and theories of chemical changes, chemical formulas and chemical arithmetic. Thus in less than fifty pages the author disposes of the basic essentials of inorganic chemistry.

Part II. Analytical and Synthetic Chemistry. Here we have a detailed account of the construction of the analytical balance, instructions for accurate weighing and laboratory procedure for quantitative and volumetric determinations of inorganic and organic compounds. This section is admirably written and suitable for a text on Quantitative Analysis, but seems out of place in a book intended for first year students of general chemistry.

Part III. Organic Chemistry. In the short space allotted to this subject the author gives a few general principles of organic chemistry, classifies the compounds and lists properties and uses of some important organic compounds. The worth of such brief discussion and long list is somewhat doubtful. More emphasis on homologous series and the inter-relationship of the typical compounds, and the citation of a few more simple organic reactions would have been of greater service to the student.

Part IV. Biological Chemistry. The descriptive portion as the other parts of the book is interesting and inspiring but the chemistry is beyond the average college freshman. Fats, carbohydrates, proteins, protoplasm, enzymes, pH measurements, and the chemistry of plants and animals are the chief topics discussed here.

Part V. Chemistry and the World's Work. This is the most fascinating portion of the book not only for the student but for the layman. Every one is interested in such vital subjects as ventilation, the chemistry of cooking and baking, bleaching and dyeing of textiles, water softeners, soil fertility and host of topics under chemistry in industry.

A number of laboratory experiments are included not with the aim to use the text as a laboratory manual but so that the student may better appreciate how the chemist works and what is the experimental evidence upon which chemical theories are based.

A more elaborate treatment of Part I, the basic principles of general chemistry and the omission of Part II, Analytical and Synthetic Chemistry would have no doubt improved the book as a text for Freshman students of chemistry. M. I. Meyer.

Meteorology, By Donald S. Piston, S. B., Assistant Professor of Physics, University of Maine, Orono, Maine. 1931. P. Blakeston's Son & Co., Inc., 1012 Walnut St., Philadelphia. $2.50 net.

This book has been written as an elementary text on meteorology for college students but is also well adapted for use of aviators and teachers of geography in both elementary and high schools. It differs essentially from other texts in that weather phenomena are explained as physical processes going on in the Earth's atmosphere under the control of the Laws of Physics. The processes of heating and cooling, rising and falling, and the horizontal movement of

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masses of air; the evaporation and condensation of moisture; the electrical and optical phenomena cannot be adequately understood without a knowledge of certain principles of physics and their application to the current weather changes.

While the usual topics are discussed in this text, they are studied in connection with the physical laws that explain them. Teachers will be most interested in chapters dealing with Laws of gases, Kinetic theory, Energy relationships, Laws of Air Flows, Radiation, Conduction, Condensation, Latent heat, Electrical phenomena, etc., and their applications to current weather conditions and behavior.

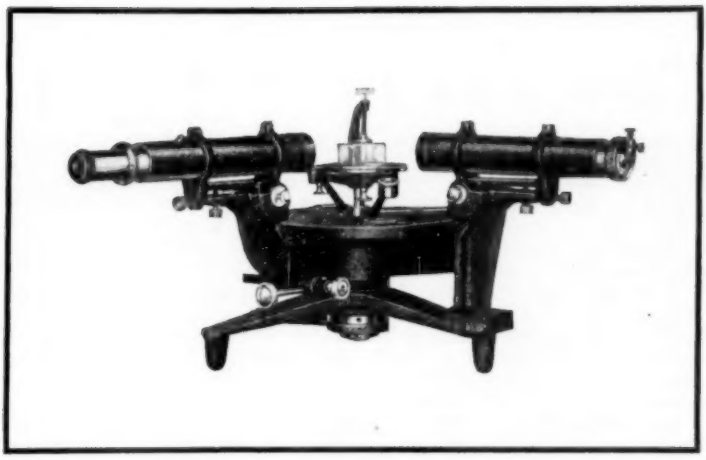
A feature of great value is the problems near the end of the book. The author considers the working of problems of the greatest value in testing one's mastery of the subject and in getting a quantitative view of the workings of Nature in the production of our weather. Formulae and the tables necessary for the working of these problems are provided.

The book should fill a long felt need inasmuch as teachers have long needed to combine pure physics and meteorology, and this appears to be the first text to adequately combine them. It cannot be quickly read for it is explanatory rather than descriptive. Many parts require considerable study. Those who are interested in developing amateur forecasters among their pupils will find much of special interest to them in this book, and all who find teaching the weather a "bore" will become enthusiastic "weather hounds" after the mastery of this text. Katharine Ulrich.

Wiedefeld-Walther Geography Test, by M. Theresa Wiedefeld, Supervisor of Elementary Schools, Maryland State Department of Education and E. Curt Walther, Head of Subject Matter Department, Geography, Maryland State Normal School, Towson, Maryland. 1931. World Book Company, 2126 Prairie Ave., Chicago. Specimen set, containing a copy of Forms A and B, Key, Manual of Directions, and Class Record, 15 cents postpaid. In packages of 25 for class use, price per package for either Form A or B is $1.15.

The test is in two parts. In PART 1, STUDY ABILITIES IN GEOGRAPHY, three abilities are measured separately for purposes of diagnosis, as follows: TEST 1. READING—measures the ability to read various types of geographical material with comprehension. It follows the general plan used in silent reading tests. TEST 2. ORGANIZATION—measures ability to recognize the worth of geographic material and to organize ideas and facts in relation to specific problems. The multiple choice method is used. TEST 3. MAP, GRAPH AND PICTURE READING—measures ability to use these special tools of geography for specific purposes. Use is made of Isothermal and Rainfall, Relief and Ocean Depth, and Political maps, of profiles of relief, and of the various types of graphs found in texts, workbooks, and current magazines. Several pictures of widely differing landscapes and cities are included. The questions to be answered through the study and interpretation of these tools have been very cleverly devised. This test represents the best effort to measure tool-using ability that the reviewer has seen. The idea behind it is capable of wide application.

In PART II, GEOGRAPHY INFORMATION, three methods of measuring knowledge are employed as follows: TEST 4 GEOGRAPHY VOCABULARY—measures ability to use geographical terms with understanding, e. g., the pupil must not only know that a junk is a boat but also that it is used in China. Multiple choice method is used. TEST 5 GEOGRAPHIC RELATIONSHIPS—measures the ability to select the one cause among a group of statements of causes which best explains a statement of effect. TEST 6. LOCATIONAL GEOGRAPHY—employs outline maps of Eastern



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This test represents a very intelligent effort to improve both the quality and quantity of geography teaching in the state of Maryland. If widely used it should have this desirable result in other states. It appears to be designed along scientifically correct lines and ranks high among the best geography tests. All teachers of geography in both grades and high school will find it of value.

Katharine Ulrich.

SCIENCE QUESTIONS

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1. Mr. Robinson lives in Detroit.
2. The brakeman lives half way between Chicago and Detroit.
3. Mr. Jones earns exactly $2,000 a year.
4. Smith beat the fireman at billiards.
5. The brakeman's nearest neighbor is one of the passengers and earns exactly three times as much as the brakeman.
6. The passenger whose name is the same as the brakeman's lives in Chicago.

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596. *Spontaneous Combustion, Friction or What?*

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Suddenly Mrs. Jones called out and the boy and I rushed back to see her standing beside a grass fire as large as a dinner plate in area. Clearly it had started between the time I passed that point and the time she reached it. The boy stamped it out. We made a diligent search but were unable to find any trace of match, cigarette, or other agent by which the fire could have been started. No airplanes had gone overhead that morning. The men in the sugar camp had not gone that way. We could see no sign of hunters or others who had passed that way.

Would the fire have started just the same whether we had passed that way or not? Did the rubbing of my boots on the dry grass generate a spark and set fire to the grass? Could a fire have lain smouldering and burst out as we passed? There was no smoke and no burned place close to the ground. Only the very tips of the grass showed any signs of fire and even there it was almost unnoticeable.

If we set this fire, how did we do it? If we did not set it, how could it start? If this is a case of spontaneous combustion, have other cases been known where similar fires have been set unaccountably?

Franklin T. Jones.

TESTS.

W. R. U.—CLEVELAND UNIT TESTS IN PHYSICS. SOUND
TEST No. 1 VOCABULARY OF SOUND

(Test constructed by David W. Evans, West High School, Cleveland, Ohio, and David P. Harry, Jr., Graduate School, Western Reserve University.)

Name.....Date.....Score (.....)
Age (.....) years (.....) months. Number of days we have studied this unit (.....). Name of Class (.....) Teacher.....
.....School.....

Directions: Read each statement in Column 2. Select in Column 1 the answer which best fits and write its number in the parentheses. Sample is correct.

Column 1 (Answers)	Column 2 (Statements)
	SAMPLE: A reflected sound wave returning to us from a distant cliff is called.....(4) S.
1. Beats	1. Irregular, non-periodic vibrations cause(.....) 1.
2. Condensation	2. The number of vibrations per second determines.....(.....) 2.
3. Doppler Effect	3. The amplitude of vibration of a sounding body helps to determine.....(.....) 3.
4. Echo	4. The number of sound waves passing a given point in one second is called.....(.....) 4.
5. Forced vibrations	5. The tone produced when a string vibrates in two or more segments.....(.....) 5.
6. Frequency	6. When two notes have frequencies as 1:2, the relation is the.....(.....) 6.
7. Fundamental	7. The tone that a piano wire gives out when it vibrates as a whole.....(.....) 7.
8. Longitudinal	8. The re-enforcement of sound caused by the union of direct and reflected waves.....(.....) 8.
9. Loudness	9. The place in a sound wave where the air particles are crowded together is called.....(.....) 9.
10. Musical sound	10. The place in a sound wave where the air particles are farther apart than normal is called the.....(.....) 10.
11. Noise	11. The points of rest in a vibrating string are known as.....(.....) 11.
12. Nodes	12. The enrichment of a fundamental tone by its overtones gives it.....(.....) 12.
13. Octave	
14. Overtone	
15. Pitch	
16. Quality	
17. Rarefaction	
18. Resonance	
19. Resonator	
20. Sympathetic vibrations	
21. Transverse	
22. Wave length	
23. Anti-nodes	

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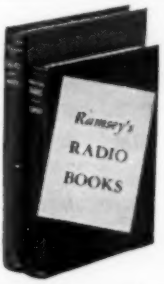

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13. As an auto approaches us, the sound of its horn increases in pitch; this is called.....(.....) 13.
14. Regular, pleasant vibrations, greater in number than 20 per second cause(.....) 14.
15. The distance from the middle of one condensation to the middle of the next one.....(.....) 15.
16. Variation in loudness, caused by alternate re-inforcement and interference of two tones.....(.....) 16.
17. A tube so adjusted that the air column inside vibrates in unison with a fork or other outside body is called.....(.....) 17.
18. When the base of a vibrating tuning fork held against a table makes the sound more intense, it illustrates.....(.....) 18.
19. Since particles in a sound wave move back and forth in the direction the sound is traveling, sound waves are(.....) 19.
20. When some object in the room is heard to vibrate when a note is struck on the piano it illustrates.....(.....) 20.

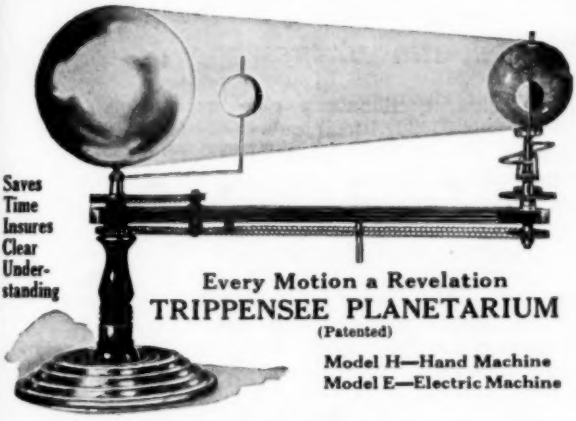
A NEW ENCYCLOPEDIA OF ELEMENTARY MATHEMATICS

By G. A. MILLER, *University of Illinois, Urbana, Ill.*

More than twenty years ago Italian mathematicians announced that they were planning to prepare a new encyclopedia of elementary mathematics and recently the second and last part of Volume I was published by the well known firm Ulrico Hoephi, Milan, Italy. This work should be of interest also to those using the English language because there is now no modern mathematical encyclopedia or dictionary in our language, and many will doubtless consult this work even if they have to do so by means of an Italian-English dictionary. Fortunately a considerable part of the mathematical language is universal and hence the student of mathematics can use works which appear in other languages than his own with less trouble than the students of many other subjects.

Moreover, a large part of the references which are found in a mathematical encyclopedia relate to work which appeared in various languages, especially in the four principal modern mathematical languages of the world, viz., English, French, German, and Italian. Hence it is impossible to secure the full benefit of such a work without the use of these languages regardless of the language in which the main body of the work is printed. The present volume is devoted to analysis and is to be followed by two more volumes devoted to geometry and applied mtahematics respectively. The last volume is expected to treat also the history and the teaching of mathematics. The first volume involves a little more than a thousand pages and contains a large number of references to early publications so that it is very useful to those interested in the history of mathematics as well as to all other students of elementary mathematics.

The headings of the twenty main divisions of this volume may be of interest because they exhibit not only the nature of work but also the view of its authors as regards the extent of modern elementary mathematics. These headings are as follows: Logic, general arithmetic, practical arithmetic, theory of numbers, progressions,



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logarithms, mechanical calculus, combinatory calculus, theory of groups, determinants, linear equations, linear substitutions, rational functions, general properties of algebraic equations, particular algebraic equations, methods for discussing problems of the second degree, limits and series, infinitesimal analysis, theory of aggregates, analytic functions.

Some readers may be surprised when they first see that the elements of the theory of groups are here included under the term elementary mathematics, especially when it is recalled that the Italian mathematicians contributed comparatively little towards the development of the group theory of analysis. They have however, made extensive contributions towards the group theory of geometry. The fact that elementary infinitesimal analysis is here classed with elementary mathematics will probably surprise fewer readers since there has been such an active movement in this direction during the last two or three decades. It may however be of interest to note that almost ten per cent of the entire volume is devoted to this subject by G. Viranti. The only general subject which is given more space therein is general arithmetic, which is treated by D. Gigh on 126 pages.

American teachers of secondary mathematics may be interested in knowing that such a work exists and may be found in many of our libraries even if they cannot make any direct use of it. Its existence exhibits the fact that elementary mathematics is a growing subject and not one whose development practically ended with the close of the seventeenth century as is sometimes stated. The developments of higher mathematics often extend not only upwards into new regions but also downwards into the very elements of our subject. This is clearly illustrated, for instance, by the theory of groups as is exhibited not only in the present work but also in the only other modern extensive encyclopedia of elementary mathematics, viz., the German work by Weber and Wellstein.

DR. FRANK LUTZ ON CORNELL SUMMER STAFF

Dr. Frank Lutz, Curator of Entomology of the American Museum of Natural History will be on the staff at Cornell this summer in connection with the course in the Teaching of Natural History in the Field. He will work with Professor E. Lawrence Palmer and will take the place occupied last year by Dr. G. Clyde Fisher of the American Museum. This course is limited to twenty students and involves camping over night each week-end on a different site. The students sleep in pup tents or sleeping bags.

RADIO TALKS ON SCIENCE

Dr. George E. Nelson, Assistant Librarian, College of the City of New York will broadcast every Thursday from 7:35 to 7:55 P. M. over station WNYC on science topics. The schedule includes the following:

Feb. 4—"Science in the World To-day."
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Feb. 18—"The History of Science."
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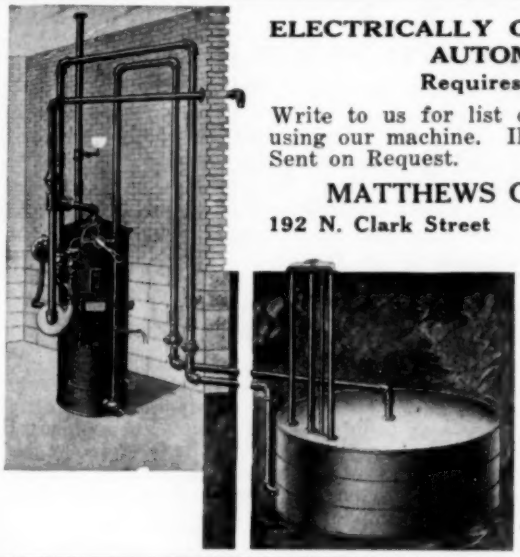

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LITTLE-SEEN INSECTS DO MOST DAMAGE

Insect fighters gathered at the meeting of the American Association for the Advancement of Science at New Orleans were called upon to combat the insect damage to hay, corn and potatoes, estimated to amount to nearly $417,000,000 annually. Prof. J. S. Houser, Ohio entomologist, laid most of the blame on white grubs and wire worms, subterranean insects whose depredations often pass unnoticed, and reported that not more than nine states were working to check this menace.—*Science Service.*

RED VINEGAR MADE FROM COFFEE IN BRAZIL

Red vinegar that looks like clear Rhinewine, smells like pear oil, and tastes like old whiskey comes from the pulp of the coffee-berry. About forty per cent of the berry is bright red pulp, nine per cent of that sugar and eight per cent tannins, F. W. Reise, chemist says. Unripe mash made from the pulp contains acid, while overripe mash develops methanol from pectin. By-products have had little utilization. Coffee is the twin-seed of a cherry-like berry that grows on a bush.

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